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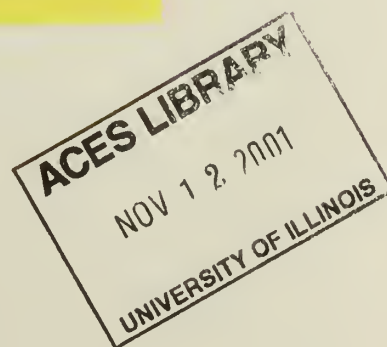
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Quarterly Report

of Selected Research Projects

January 1 to March 31

United States
Department of
Agriculture



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Into the Marketplace

Cooperative Research and Development Agreements

...With Perdue Farms of Salisbury, MD, to turn chicken feathers into a biodegradable substitute for wood or synthetic fibers such as plastics or nylon. By studying feathers in a magnetic resonance spectrometer, a device similar to the MRI imagers used in hospitals for brain scans, an ARS scientist discovered the properties that make the feather an engineering marvel. It has strong fibers that are more absorbent than wood or plastic. A newly-developed, fiber separation process uses less water, energy and chemicals than for other fibers. Initially, the feather fibers will be used in disposable diapers, hospital "wipes" and feminine hygiene napkins. Future products may include air filters, oil filters, specialty papers and structural compos-

Contact the scientists who are listed for further information on each research project. For general questions about this report, contact Sean Adams or Lisa Spurlock, ARS Information, 6303 Ivy Lane, 4th Floor, Greenbelt, MD 20770, (301) 344-2723/2824, sadams@asrr.arsusda.gov or lspurloc@asrr.arsusda.gov

Items marked with the word PATENT are being patented by ARS. For more information on patents, CRADAs and patent licenses, contact C. Andrew Watkins, National Patent Program, Bldg. 005, Rm. 416, BARC-West, Beltsville, MD 20705, (301) 504-5734. Questions about a company's product and/or research should be directed to the company itself.

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ites similar to fiberglass. Feather fibers cost less than most wood or synthetic fibers. They also distribute moisture more evenly, increasing the fiber's absorbency powers. And they can be composted in anyone's backyard in three weeks, as long as commercially available microbes are added. (PATENT APPLICATION 08/175,077)

ARS Contact: Walter F. Schmidt, Environmental Chemistry Laboratory, Beltsville, MD, (301) 504-5030

...With Tenneco Packaging, Inc., Canandaigua, NY, to develop biodegradable containers made with wheat starch. Researchers will investigate techniques to process the starch. That way, equipment used to make food and beverage containers from petroleum-based plastics might produce inexpensive, starch-derived substitutes. The research could lead to low-cost, single-use containers readily disposable by environmentally sound methods such as composting. This could spawn a new market for wheat starch and boost farm income.

ARS contact: Gregory M. Glenn, Cereal Product Utilization Research, Albany, CA, (510) 559-5677

...With Advanced Information Management and Movement, Inc. (AIM), of Starkville, MS, to determine if instruments designed for espionage and war can be adapted to agriculture. Systems made to detect traces of dangerous chemicals on battlefields may be used by agricultural computers to detect traces of insect chemical scents, called pheromones, that signal an oncoming attack of pests. In addition, catfish farmers could use this program to detect off-flavors in ponds. Radar systems designed to detect troops and tanks could be used to measure growth in cotton. Tools the U.S. Central Intelligence Agency uses to hear distant conversations may pick up leaf movements when pests are feeding. Systems designed by the National Aeronautics and Space Administration to chart weather patterns may be used to detect plant stress and soil moisture when used with non-piloted aircraft.

ARS Contact: Jim McKinion, Crop Science Research Laboratory, Mississippi State, MS, (601)324-4376

...With Sonoco Products, Inc., Hartsville, SC, to test colored plastic mulches that can boost yields of tomatoes and other crops. Sonoco produced a red plastic mulch based on a formula developed by ARS scientists, and the mulch is now being marketed by Ken-

Bar, Inc., Reading, MA. ARS research has shown that red mulch stimulates plant growth more effectively than black mulch. Red mulch reflects certain wavelengths of light that make the plant act like it's being crowded by neighboring plants. In response, the plant puts more energy into above-ground growth, including fruit. In preliminary field studies, tomato plants grown with the red plastic produced 500 number-one fruit in the first two and a half weeks of harvest—about 20 percent more than the 410 fruit from plants grown with black mulch. Scientists are now testing the red mulch formulation on tomatoes and other crops including strawberries and peppers in Colorado, Kentucky, Maryland, Pennsylvania and South Carolina.

ARS Contact: Michael J. Kasperbauer, Soil, Water and Plant Research Center, Florence, SC, (803) 669-5203

...With Rishellco, Inc., of Crowley, LA, to create a low-fat alternative to french fried potatoes using rice. ARS researchers have found that using rice instead of potatoes lowers fat content in fries by up to 50 percent. Subtle differences in the chemistry of rice seem to make it better at keeping fat out. Rice fries can be flavored with onion or spices to make a tasty snack. The fries will be made from fine flour, using a machine similar to those used in making breakfast cereals.

ARS Contact: Ranjit Kadan, Southern Regional Research Center, New Orleans, LA (504) 286-4332

...With the Canola Council of Canada, Winnipeg, Manitoba, to study canola meal as an alternative protein source in channel catfish feeds. The canola would be a partial or total substitute for more costly soybean meal. Researchers are studying the catfish's growth, feed utilization efficiency, survival rates, body composition, immune response and disease resistance in evaluating canola meal. Switching from soybean meal to canola meal would hold down costs for fish farmers and provide an expanded market for canola. Feed accounts for 40 to 60 percent of aquaculture production costs.

ARS Contact: Chhorn Lim, Fish Diseases and Parasites Research, Auburn, AL, (334) 887-3741

...With Dynamax, Inc., of Houston, TX, to automatically control irrigation systems based on how much water is stored in the soil. Designed by ARS researchers, a computer-operated system turns on water pumps only when there's not enough water for plant roots to take in. An electronic pulse is sent through a cable to stainless steel soil probes placed in the ground to varying depths—from every couple of inches down to several feet. Water content in the soil is then computed, based on the time it takes the pulse to travel through the probe: The longer it takes, the more water available. The

probes work in most irrigated agricultural soils. Dynamax, which is now manufacturing the system, will develop it further with help from ARS and Texas A&M University researchers to control irrigation for cotton and other field crops. Another likely use is automated greenhouse watering. It is expected that the system's cost may be offset by labor savings and lower expenses from pumping water only when needed.

ARS Contact: Steve Evett, Water Management Research, Bushland, TX, (806) 356-5775

...With James Nolen and Company, Warwick, RI, to develop traps and other tools to monitor and control mosquitoes, biting flies and midges. Few chemicals are now registered to control these pests, so alternatives are needed. Traps are one option; they would reduce the need for spraying chemical insecticides in residential and commercial areas. The company and ARS scientists will develop and test a variety of traps and two chemical attractants, octenol and carbon dioxide, as lures. Carbon dioxide is a universal attractant for mosquitoes, flies and other insect pests, while octenol—found in cow's breath—attracts certain mosquito and fly species.

ARS contact: Daniel L. Kline, Medical and Veterinary Entomology Research Laboratory, Gainesville, FL, (352) 374-5933

...With Pioneer Hi-Bred International, Johnson, IA, to find genetic markers that will allow scientists to "fingerprint" corn and other crops. Researchers will focus on genetic markers called simple sequence repeats (SSRs), patterns that are unique to an individual plant. The goal is to isolate and automatically screen these SSRs in specific plant cultivars—giving each plant its own individual "fingerprint." Such information will be helpful to plant breeders, because they will know without question a plant's genetic background when they breed new varieties. Germplasm curators can also use the fingerprints when cataloguing their collections. Now curators often don't know, or can't be sure, about the precise genetic identity and makeup of each cultivar in their collections. Genetic "fingerprinting" could help solve these problems.

ARS contact: Stephen Kresovich, Plant Genetic Resources Conservation, Griffin, GA, (404) 228-7254

...With three commercial firms to test laboratory-designed compounds that mimic natural pest-killing chemicals made by a wild tobacco plant. The compounds, synthetic sucrose esters, quickly penetrate whiteflies and other soft-bodied pests of many crops. The pests start dying within a half hour. An ARS scientist designed the synthetic molecules, which consist of sugar with attached fatty acids. The same components make up natural sucrose esters in leaves of *Nicotiana*

gossei, a wild Australian relative of commercial tobacco. Synthetic esters killed up to 100 percent of silverleaf whiteflies, aphids, leafhoppers and mites in lab and greenhouse tests. In an initial field trial, the esters cut whitefly populations by nearly half. The esters should be easy and economical to mass-produce and, unlike some conventional insecticides, are quickly and completely biodegradable. ARS scientists are testing the synthetic sugar esters on field crops, including fruits and vegetables, under a CRADA with Rohm and Haas Co., Spring House, PA. A CRADA with Fuller System, Inc., Woburn, MA, will examine using the esters to protect ornamentals and greenhouse plants. Tests with pecans and other tree fruit and nut crops will be conducted with Griffin Corp., Valdosta, GA. The agency is seeking a patent on use of the esters.

ARS Contact: O.T. Chortyk, Natural Products Utilization Research, Athens, GA, (706) 546-3424

...With BASF Corp., Research Triangle Park, NC, to test whether a plant growth regulator made by that company can reduce the number of undeveloped cotton fibers that cause imperfections when a mill dyes cotton. The regulator, sold under the name PIX, is currently used throughout the cotton belt to reduce plant height (so the plant uses its energy to grow bolls) and enhance boll production. New tests will determine if the regulator has the potential to prevent drought-induced damage in cotton grown in dry areas. Without irrigation, western-grown cotton can develop more than its share of immature fibers. Texas A&M researchers, also part of this research, will grow treated cotton plants with and without irrigation. They will also grow control groups under similar conditions. Then, ARS researchers will test the fiber quality of the harvested cotton.

ARS Contact: Gayle H. Davidonis, Southern Regional Research Center, New Orleans, LA, (504) 286-4273

...With instrument company Zellweger Uster, Inc., of Knoxville, TN, to use a new electrical sensor to measure cotton fiber moisture during quality checks. Originally developed by ARS researchers for cotton ginning, the sensor can be used in other industries such as textile processing and cotton marketing classification. By measuring and adjusting for moisture levels, the sensor can help predict fiber strength and other fiber qualities. This reduces or eliminates the need for a costly pre-classification conditioning process in which cotton samples are held in a controlled environment for up to 48 hours to restore natural moisture levels lost during ginning. ARS and Zellweger Uster are validating a moisture measurement system for its eventual commercialization and introduction into the cotton industry. (PATENT APPLICATION 08/273,244)

ARS Contact: W. Stanley Anthony, U.S. Cotton Ginning Laboratory, Stoneville, MS, (601) 686-3094

Genetic Resources

Apple seeds from rare, wild trees in Central Asia offer a potential genetic bonanza for breeders looking for better flavor, disease resistance and other traits.

ARS and university plant explorers, who collected more than 60,000 seeds last summer, are now analyzing traits of young plants grown from the seed. The trip was the third in a series to Central Asia, where the modern domestic apple is thought to have originated. The scientists collected seed and cuttings from the wild species *Malus sieversii*. It's a forerunner of the domestic apple, *M. x domestica*, which includes Red and Golden Delicious, McIntosh, Granny Smith and other popular varieties. One of the richest collecting sites was in the Tarbagatai mountain range, not previously visited by the American team. Tarbagatai, where winter temperatures dip to -40 degrees F, is the northernmost limit of *M. sieversii*. So, the new germplasm could someday extend apple growing farther north on this continent. The biggest apples the researchers collected—up to three inches in diameter—were found in the Tarbagatai area. Of the superior types collected, 84 percent had a pleasant, aromatic flavor and 70 percent were free of scab, a fungal disease.

Plant Genetic Resources, Geneva, NY

Philip L. Forsline, (315) 787-2390

A protein found in stored Golden Delicious apples can protect the fruit from storage rots. Also present in pears, tomatoes and raspberries, the protein stops the rampage of an enzyme produced by a pathogenic fungus, that attacks fruit after harvest. This is the first time that the protein, called polygalacturonase-inhibiting protein, has been purified from apples. Found in the apples by ARS scientists, the protein decreases as the fruit matures. The decrease occurs at a time when the fruit still needs protection from organisms that cause decay. Growers have long protected fruit from rots with fungicides, but many of the chemicals are no longer available because of health and environmental concerns. Scientists are cloning the gene responsible for producing the protein. They plan to manipulate the gene to produce large amounts of the protein as the fruit matures. It will be some time before they produce transgenic apple trees with the new gene, but once it has been inserted into tissue-cultured plants, they will be ready for field tests.

Horticultural Crops Quality Laboratory,

Beltsville, MD

William S. Conway/Chenglin Yao, (301) 504-6128

A specific site on Chromosome 23 in Holstein dairy cows may hold a vital clue to whether a particular cow is more prone to mastitis infection. Mastitis is a bacterial infection of dairy cows that costs U.S. farmers

more than \$2 billion annually for treatment and lost milk production. Researchers studied the DNA of "grandsires" from seven different families of Holstein cattle, noting any genetic differences at three locations on each chromosome of the bulls. They discovered the lineup of genes at a specific site on Chromosome 23 differed between bulls whose daughters' milk contained high numbers of somatic cells—indicating a greater rate of mastitis—and bulls whose female offspring had lower somatic cell scores. Their conclusion: One particular variation in the DNA appears to be linked to lower somatic cell scores than in all other genetic lineups at that spot on Chromosome 23. Next, the researchers will check the DNA of Holsteins in a Maryland dairy herd, test those animals to see how well they resist mastitis infection, and decide whether the DNA predictors are accurate. If they can pinpoint which DNA lineups suggest reduced mastitis susceptibility, prospective breeding animals could be screened in advance for resistance to the disease.

*Gene Evaluation and Mapping Laboratory,
Beltsville, MD*

Melissa S. Ashwell, (301) 504-8543

A map of the human genetic makeup is helping ARS scientists save time and money as they sort out and map chickens' genes. An initial genetic map for chickens has been developed. It will help breeders in the future produce birds known to carry the best genes for traits such as disease resistance and egg and meat production. To help complete the process of breeding a better chicken, scientists hope to find the exact genes by using information from the human genetic map. While the genetic makeup of chickens and humans isn't a particularly close match, researchers say there is enough similarity that information already available on the human genetic map can be used to search for specific genes in poultry. That's because during evolution, certain "chunks" of genes may have traveled together. So, a gene that's linked to arm length in humans might occupy approximately the same chromosomal location as genes related to wing growth in birds.

*Avian Disease and Oncology Research, East
Lansing, MI*

Hans Cheng, (517) 337-6758

A variety of taro called Lila can triple the yield of this root crop on tropical farms. Taro produces underground stems, called corms, that are an excellent source of starch and minerals. The stems can be boiled, baked or roasted. When cooked, a corm tastes like a potato but has a softer texture. ARS scientists conducted field studies of Lila and found that, if properly fertilized and irrigated, it produces up to 17,770 pounds of

commercial corms per acre—a 230 percent increase over the worldwide average for the crop. One reason for the yield increase: Lila was more efficient than other varieties in using soil nutrients. Taro is grown more widely in Pacific Island countries than in the Caribbean—partly because little attention has been paid to its potential compared to similar vegetables. In Puerto Rico, taro is grown on a small scale, though scientists say the findings could help boost taro production throughout the Caribbean and in other parts of the world.

*Tropical Agriculture Research Station, Mayaguez, PR
Ricardo Goenaga, (787) 831-3435*

Genes in a wild tobacco plant may give food and fiber crops a new defense against silverleaf whiteflies and other pests. Those genes could enable cotton, tomatoes and other crops to make the same natural chemicals the wild plant makes to kill the leaf-feeding insects. That's the objective of ARS scientists who have been analyzing the genetics of *Nicotiana gossei*—a wild Australian relative of commercial tobacco. *N. gossei* produces a number of insecticidal chemicals including sucrose esters. In lab and field tests, the esters have killed whiteflies, aphids, spider mites, pear psyllas and tobacco hornworms. Now, the scientists are pursuing genetic research, seeking to identify and isolate the sucrose-ester genes. Ultimately, scientists would insert the appropriate genes into crop species as a potential new form of nature-based pest control.

*Soybean and Alfalfa Research Laboratory, Beltsville,
MD, George Pittarelli, (301) 504-5723*

*Western Cotton Research Laboratory, Phoenix, AZ
David Akey, (602) 379-3524*

Medical researchers may more quickly locate "jumping genes"—also known as transposons—that could have potential use in gene therapies. That's because ARS scientists and a software engineer at Silicon Graphics, Mountain View, CA, devised a transposon-finding mathematical formula. The team's intent is to design on-off switches for lab-built genes geared, for example, to protect potatoes from bacteria. But the team first needs to find more plant transposons. They then can devise new gene switches to mimic the transposons' genetic architecture. The ARS-designed formula, called an algorithm, instructs a supercomputer to search a gene database for patterns associated with transposons. The scientists recently tested the algorithm on the human gene data base. They knew this would be a tougher challenge than the much smaller database of plant genes. But the algorithm might also speed medical scientists' search for additional human transposons. New transposons might prove valuable for moving potentially beneficial genes into cells of patients suffering from

AIDS, cancer or gene-linked diseases. The ARS team found two human transposon genes—one previously unknown, one only partially described before.

*Crop Improvement and Utilization Research,
Albany, CA*

William R. Belknap, (510)559-6072

Crop Productivity

ARS is cooperating with NASA on a five-year research project involving plant growth in zero gravity. NASA wants to grow produce on space shuttle flights as a source of food for the astronauts and to provide an extra source of oxygen. The problem is getting plants to grow in low-gravity environments. Gravity affects calcium balance in plants and people. In humans, it can damage bones, and in plants, it may interfere with root development. ARS scientists will be using a clinostat to test how plants adapt to weightlessness. A clinostat rotates the plant slowly so the net gravity effect is close to zero. Another way to disrupt gravity for plants: simply turn them on their sides. ARS scientists will be cooperating with other researchers at the Kennedy Space Center and several universities. The project is in its earliest stages with experiments being designed and coordinated between agencies.

*Soybean and Nitrogen Fixation Lab, Raleigh, NC
Steve Huber, (919) 515-3906*

Cultivated sunflowers may become a common sight on land that's now unproductive or produces poor crops because it's overloaded with mineral salts. ARS geneticists have identified genes in a species of wild sunflower called *Helianthus paradoxus* that enable seedlings to withstand the salts. That salinity tolerance trait has been bred into some experimental sunflower lines. This trait could also provide drought tolerance that would boost acreages capable of producing sunflowers. Salts build up usually in soils in dry areas that have been irrigated excessively.

*Oilseeds Research, Fargo, ND
Jerry F. Miller, (701) 239-1321*

Farmers and ranchers can fire up the productivity of land coming out of the federal Conservation Reserve Program (CRP) at the end of the year by burning dead grasses and weeds off the surface this spring. In grassland management experiments, ARS scientists pinpointed "prescribed burning"—a fire set under carefully controlled conditions—as the most cost-effective and efficient way to remove accumulated dead grasses and weeds from government set-aside land. Burning old vegetation encourages growth of forage grasses and suppresses weeds. The first of thousands of CRP

contracts are due to expire this year. The CRP was initiated in 1986 to protect highly erodible crop land.

*Wheat, Sorghum and Forage Research, Lincoln, NE
Bob Masters, (402) 472-1546*

The first bale of cotton harvested in the United States last year was a new, early-maturing, commercial variety, bred from germplasm developed and released by ARS a couple of years ago. The new cotton offers some natural protection against silverleaf whiteflies. Growers need every possible edge to reduce the damage done by these voracious pests that attack many crops including cotton, citrus, melons, tomatoes, other vegetables and ornamentals. Cotton plants of the ARS germplasm line—and the new variety called Texas 121—mature a week earlier than other varieties. This allows the crop to partially escape the usual late-season buildup of whitefly populations in south Texas cotton fields. Other characteristics of the new variety, such as smooth leaves, make the plants less attractive to whiteflies as sites to feed and lay eggs. For producing hybrid cotton seed, ARS released different germplasm—called fertility-restorer lines. These lines also have the smooth-leaf and other traits. The traits will be passed on to offspring even if only one parent is a hairy-leaf type.

*Conservation and Production Systems Research,
Weslaco, TX
Charles Cook, (210) 969-4812*

Asparagus growers in the Pacific Northwest can stop tilling fields—thereby cutting soil erosion—without losing yields. Tillage uproots weeds but leaves soil bare and vulnerable to wind and water erosion. So, ARS scientists modified techniques used by Midwestern asparagus growers to control weeds with minimum use of safe herbicides. Some farmers near Prosser, WA, now are using these methods. Washington farmers had been reluctant to drastically change their time-honored tillage farming until the scientists showed the techniques worked. In Washington, asparagus valued at about \$56 million a year is grown on 30,000 acres. Much of the acreage is sandy, easily eroded soils. Several effective herbicides now are registered for use on the crop.

*Irrigated Agricultural Research and Extension
Center, Prosser, WA
Rick A. Boydston, (509) 786-9267*

Carrot seed growers who give their plants precise amounts of water will produce more clean, live seed. A three-year ARS study of carrots' water demands documented key differences in the requirements of two carrot types—"Imperator," the tapered carrots popular in the United States, and the cylindrical, European-style "Nantes." The tests, based on analysis of 2,000 plants grown from transplanted carrots at a central California

research field, also showed that the carrots raised in a hot, dry climate similar to the study site need about 22 to 25 inches of water from the time the transplant goes into the ground until seed harvest. Related findings from the study allow seedgrowers at other sites in California, Idaho, Oregon, Washington and elsewhere to calculate optimum irrigation for carrots. For the 1995 carrot crop, American seedgrowers produced about 400,000 pounds of carrot seed with a farm-gate value of about \$16 million. The 1995 carrot harvest of 3.8 billion pounds was worth about \$448 million to producers. Carrots, America's sixth most popular vegetable, provide a low-calorie source of fiber, potassium and beta-carotene—the nutrient that our bodies use to form vitamin A. We each eat about 11 pounds of carrots a year.

*Water Management Research Laboratory, Fresno CA
Robert B. Hutmacher, (209) 453-3100*

*National Forage Seed Production Research Center,
Corvallis, OR*

Jeffrey J. Steiner, (503) 750-8734

Crop Diseases and Pests

A new, 10-minute sampling technique performed weekly during the prime, cotton-growing season is easier, faster and more accurate in predicting outbreaks of destructive silverleaf whiteflies. The technique, now widely used in Arizona, California and northern Mexico, only requires that 30 leaves in a 40- to 80-acre cotton field be turned over and examined. Scientists used statistical analysis to determine that samplers only need to record how many leaves have three or more of the insects. When 57 percent fit this definition, it is time to apply insecticide. If the average is around 50 percent, it's time to increase sampling frequency to every three or four days. Older methods—besides being slower—often were not accurate, leading some growers to apply insecticide unnecessarily. One application can cost up to \$25 per acre. Silverleaf whiteflies cost the United States about \$300 million a year because of crop losses, control costs, and other factors such as unemployment created when insects destroy fields so they aren't worth harvesting.

*U.S. Western Cotton Research Laboratory,
Phoenix, AZ*

Steve E. Naranjo, (602) 379-3524

Wheat germplasm from India and Mexico contain genetic resistance to a disease that could threaten U.S. wheat exports. In a special quarantine lab in Frederick, MD, ARS scientists confirmed that selected varieties had resistance to Karnal bunt, a disease caused by the fungus *Tilletia indica*. The selected varieties were picked from 40,000 wheat lines taken from international germplasm

collections at Punjab Agricultural University in India, and CIMMYT in Mexico. The selections were then screened for resistance to Karnal bunt. This damaging disease is quarantined around the world—meaning countries that don't have the fungus won't buy wheat from countries where Karnal bunt is found. So keeping the disease out of American wheat—a chief export crop valued at \$4 billion in 1994—has been a top priority. Currently, USDA agencies are working to eradicate a Karnal bunt outbreak that was detected earlier this year in durum wheat seeds originating in Arizona. In the lab tests, scientists found resistant germplasm from Mexico that was also resistant to the pathogen from Asia. They also found resistant wheat lines from India that ward off strains of the fungus from Mexico. By incorporating these resistant lines into U.S. wheat, breeders might be able to protect the American crop from Karnal bunt outbreaks such as the one in Arizona in March 1996. The United States exported nearly 1.3 billion bushels of wheat in 1994, making it one of the country's top crops for overseas markets.

*Foreign Disease/Weed Science Research
Laboratory, Frederick, MD*

Morris Bonde/Gary Peterson, (301) 619-2860/7313

Planting cover crops under trees and interplanting peach trees with apple trees can cut chemical use in fruit orchards. That's the finding from similar, cooperative studies in West Virginia and four countries in Europe. When the trees begin to bear fruit, strips of rape, buckwheat, dill, and dwarf sorghum planted between tree rows play roles in controlling orchard pests. Rape is toxic to damaging nematodes. Buckwheat flowers produce nectar and pollen to feed beneficial insects. Flowers from dill harbor beneficial parasites. And dwarf sorghum attracts aphids to the sorghum where these pests become food for beneficial insects. Peach trees act as an excellent food source for beneficial insects, when interspersed among apples trees. An ARS lab worked out this diversified approach that was then tested successfully in orchards in Romania, Poland, Hungary and the Czech Republic. ARS scientists will conduct more studies of ground cover use in Poland.

*Appalachian Fruit Research Station,
Kearneysville, WV*

Mark W. Brown, (304) 725-3451

A second race of the devastating golden nematode found in U.S. potato fields will encounter formidable obstacles in new resistant potato germplasm lines. From 1941 to 1994, it was believed that U.S. potato growers faced only one race of golden nematode, Ro1, found in a handful of counties in New York. Plant breeders have provided growers with more than 30

potato varieties resistant to Ro1. But in 1994, resistant varieties in test plots began falling prey to another golden nematode—race Ro2. Cooperative research between ARS and Cornell University to develop potatoes capable of fending off other nematodes has already yielded germplasm that is resistant to Ro2. A potato variety that resists both races may be available for release to growers within the next five to 10 years. The golden nematode, *Globodera rostochiensis*, can wipe out entire crops of potatoes by feasting on the plants' roots. To make matters worse, each female nematode can produce hundreds of eggs capable of lying dormant in the soil for decades, waiting for the right soil conditions and a vulnerable potato crop.

Plant Protection Research, Ithaca, NY
Bill B. Brodie, (607) 255-2158

Aggressive species of crop-destroying moths can spread at a rate of eight to 113 miles a year—the majority traveling 15 to 28 miles a year. ARS scientists identified the rates for 10 foreign species introduced into North America. This information will be useful to scientists working on insect pest control strategies with growers in multiple states. Moth species of the insect order *Lepidoptera* have become serious pests of U.S. crops. Of the moth species studied, the European gypsy moth spreads the slowest—an average of about eight miles a year—probably because of its flightless females. The browntail and satin moths, in the same family as the gypsy moth but with flying females, spread much faster—at 26 and 28 miles per year. The fastest of the accidentally introduced species are two cutworm moths. One travels 113 miles a year and the other at least 99 miles in one continuous flight over water. Researchers estimated that the time required for various introduced species to occupy all suitable habitat in the United States and Canada varies from 30 to 100 years. Nearly all accidentally introduced *Lepidoptera*—an estimated 123 species—are of European origin. And six of those studied came into the United States from both the East and West coasts. Seaports, rather than airports, have been the major points of entry.

Systematic Entomology Laboratory, Washington, DC
Doug Ferguson, (202) 382-1777

An insect virus discovered by an ARS researcher some 30 years ago has become a workhorse of modern biotechnology. The virus was found in the alfalfa looper caterpillar, *Autographa californica*. Today, this virus speeds research on proteins that might protect people and animals from disease. It may also have other uses. Scientists in more than 500 labs throughout the world employ university- and industry-developed technology to re-tool the virus so it produces the proteins. This safe, efficient approach often is superior to

relying on cultures of *E. coli* bacteria or mammalian cells. The *A. californica* virus multiplies inside cultures of insect cells in laboratory flasks. There, it yields proteins that are closer to their natural form than those produced by *E. coli* cultures. And, the insect cells are easier to raise than mammalian cells. Meanwhile, agricultural researchers are working to accelerate the virus' outdoor performance as an environmentally friendly insecticide. It could protect such crops as cotton or cabbage from their worst caterpillar enemies.

Horticultural Crops Research Laboratory,
Fresno, CA

Patrick V. Vail (209) 453-3000

A simple test that detects a chemical in birch tree bark could help plant breeders identify species and hybrids that can be used to develop trees that are resistant to the bronze birch borer. True birch (*Betula*) species are extremely difficult to identify because of extensive hybridization in the wild or in cultivation. ARS scientists used a simple test to determine the presence of a chemical called platyphylloside, found in the inner bark of birch branches. Over 500 birch trees were tested, representing over 70 species, varieties and hybrids. Although relatively few species or hybrids were positive for the chemical, the test enabled scientists to confirm or suspect the identities of many birches in major U.S. arboreta. Besides helping to identify trees that could be used to breed resistance to the bronze birch borer, the test uncovered evidence that the presence of platyphylloside may make certain birches susceptible to attack by the European hornet that causes bark stripping.

U.S. National Arboretum, Washington, DC

Frank Santamour, (202) 245-4570

Animal Productivity

Romosinuano cattle, a South American breed, may pass along more traits that are ideal for cattle production in the southeastern United States. ARS brought 143 Romosinuano embryos from Venezuela to Florida where researchers implanted them in surrogate cows. Objective: to evaluate the foreign breed's qualities that are most desirable for cattle herds in the southeast. Romosinuano mature quickly, resist insect pests and heat, and have consistent carcass quality and good temperament. Southeastern cattle producers now have to select for one or two traits at the sacrifice of other desired ones. Because of U.S. import restrictions, it took five years and the cooperation of the Venezuelan government to arrange this embryo transfer. The only U.S. herd with Romosinuano genes is highly inbred and therefore not the best predictor of the breed's true potential.

*Subtropical Agricultural Research Station,
Brooksville, FL
Chadwich Chase, Jr., (904) 796-3358*

A new formula for estimating a dairy herd's manure production and nitrogen content may help dairy farmers use less commercial fertilizer and make their farms both cleaner and more efficient. ARS researchers developed the formulas, which use data already in a farmer's records. Various factors are taken into account, such as where a cow is in her milk-producing cycle and the fiber and protein in her diet. Currently, industry standards use a "one size fits all" method to project waste data. But ARS research found predictions were more accurate when a cow's milking cycle was taken into account. Testing the new and old formulas on 600 dairy cows, researchers found accounting for pregnancy and other factors increased accuracy on estimates of nutrient content and total waste mass. When farmers can make accurate predictions about nitrogen content in herd manure, they can use animal waste more effectively—including replacing commercial fertilizers. Across the country, state governments are requesting that farmers reduce waste runoff to protect waterways. Agricultural engineers may be able to use the new formula to build better storage and handling systems.

*Nutrient Conservation and Metabolism Unit,
Beltsville, MD
Vic Wilkerson, (301)344-8620*

Animal Diseases and Pests

Just because a cat has antibodies in its blood indicating previous infection with *Toxoplasma gondii* is no assurance that it can't become reinfected with the parasite. That's in sharp contrast to the longstanding belief that once infected, a cat could not become reinfected later and begin shedding an egg-like form of *T. gondii* again in its feces. Now, ARS researchers are testing a commercially developed vaccine for cats that makes them immune to infection by *T. gondii* and stops the parasite-egg shedding. Cats would be vaccinated annually, especially weaned kittens that are a main source of infection. Although *T. gondii* infects animals and humans worldwide, cats are the only creatures known to excrete *T. gondii* oocysts, a form of the parasite that easily withstands nature's harshness. Humans can become infected by swallowing the oocysts. Healthy people other than pregnant women can weather *T. gondii* infection with few ill effects. But if a pregnant woman becomes infected, there is a 20 to 50 percent probability that her baby will be infected, possibly resulting in blindness, mental retardation or

other medical problems for the child. The national cost of raising children infected this way was estimated in 1993 at \$5.3 billion.

*Parasite Biology and Epidemiology Laboratory,
Beltsville, MD
J.P. Dubey, (301) 504-8128*

A vaccine for baby pigs may be one step closer in the fight to eradicate a disease that costs U.S. pork producers \$60 million a year. Pseudorabies is fatal to young pigs and causes abortion in pregnant sows. Until now, it's been difficult to protect baby pigs by vaccinating them. Current vaccines haven't protected young pigs during a critical time—when immunity from their mothers' milk begins to decline but before immunity from vaccination takes effect. ARS researchers evaluated combinations of proteins delivered by vaccinia virus—the one used to vaccinate humans against small pox. They found that one protein called gB stimulated an immune response in baby pigs with high maternal antibodies. A gB protein-vaccinia virus combination also reduced the amount of shedding of the pseudorabies virus, which cuts down on the spread of the disease. That combination could be the basis for making a new pseudorabies vaccine for young pigs.

*Swine Virology Research, Ames, IA
Susan L. Brockmeier, (515) 239-8371*

Quick identification of another virus that kills unborn and weakens newborn baby pigs can further help reduce losses to pork producers. Previously known as mystery swine disease, porcine reproductive and respiratory syndrome (PRRS) is one of the most costly diseases to the swine industry. It has been estimated to cause losses that range from \$50 to \$250 per affected sow per year. ARS researchers used a technique called restriction enzyme analysis to characterize 90 isolates of the PRRS virus from pigs. The test separated those isolates from pigs with PRRS virus strains versus vaccinated pigs. Until now, producers had no means to differentiate the vaccine strain of PRRS virus from field strains. Humans cannot be infected by PRRS virus. (PATENT APPLICATION 08/609/334)

*Virology Swine Research, Ames, IA
Ronald D. Wesley, (515) 239-8305*

An outbreak of human leptospirosis in Nicaragua was traced to its source—domestic dogs—using a diagnostic test developed by ARS veterinarians. Prior to ARS diagnostic work, other researchers and health officials suspected rats might be the source of the bacteria that produced pulmonary hemorrhaging leading to illness and death in thousands of Nicaraguans. ARS research indicates that domestic dogs rather than rats were the source of infection. Humans can get leptospirosis from being exposed to animal urine through contaminated soil

or water. Over 200 different strains of bacteria cause leptospirosis. A polymerase chain reaction test confirmed the exact strain that caused the outbreak.

Zoonotic Diseases Research, Ames, IA

Richard L. Zuerner/Carole A. Bolin, (515) 239-8325

Nature lends a hand to animals infected with gastrointestinal worms. That finding by ARS scientists could lead to a new way to treat parasite-infected humans and animals. While all the mechanics of this process aren't understood, it's known that a natural product of immune cells, interleukin-4 (IL-4), helps start the worm expulsion process. Production of IL-4 is stimulated by worm infections. In lab tests, researchers injected IL-4 into normal mice. The result: The mice's intestinal muscle contractions increased and additional fluids were secreted. The combination of these actions could dislodge worms from the intestine. Researchers say this discovery could lead to man-made copies of natural IL-4 for use in treating parasite-infected humans and animals.

Immunology and Disease Resistance, Beltsville, MD

Joseph F. Urban, Jr., (301) 504-8765

From the parasite in drinking water that sickened thousands in Milwaukee in 1993, more bad news: Cold doesn't necessarily stop *Cryptosporidium parvum*. It was once thought this waterborne, infectious parasite could be killed by freezing. But new ARS studies show oocysts—egg-like forms of the parasite—are still potent even after days of freezing temperatures. Oocysts were alive and infectious after being frozen in water at 14 degrees F for a week, at 5 degrees F for a day, and at 4 degrees below zero F for eight hours. Most household freezers run between +5 and -4 degrees F. So, ice made from oocyst-contaminated water must be considered infectious until it's been held at least 24 hours before use. Another unhappy conclusion: Oocysts have the potential to survive mild freezing temperatures in the environment and might be able to overwinter. *Cryptosporidium* infection in humans can be triggered by as few as 30 oocysts. *C. parvum* also wreaks havoc in livestock, causing severe diarrhea called "scours" in baby beef and dairy calves. In one study, the parasite was found in virtually all the calves checked during the first 30 days of their life.

Immunology and Disease Resistance Laboratory,

Beltsville, MD

Ronald Fayer, (301) 504-8750

On another front, a product from cattle's white blood cells appears to be a promising shield against cattle infection caused by *Cryptosporidium parvum*. In lab tests, ARS researchers found the product made from cattle's white blood cells blocked *C. parvum* infection in

highly susceptible white mice. The researchers have cloned the gene for the white blood cell product and will test it in cattle. *C. parvum* causes heavy losses in beef and dairy herds nationwide. In one survey of 28 states, cryptosporidium was found in all 28 states, on 59 percent of the 1,100 farms surveyed, and in 22 percent of the 7,400 calves checked. In another study, it was found in virtually all of the calves checked during the first 30 days of their life.

Immunology and Disease Resistance Laboratory,
Beltsville, MD

Ronald Fayer, (301) 504-8750

A genetic immune disorder in Holstein cattle has been effectively eliminated from the breed by removing carrier bulls. Holsteins are the mainstay of the \$19 billion U.S. dairy industry. ARS researchers were the first to confirm that bovine leukocyte adhesion deficiency (BLAD) was an inherited disorder. They further developed a diagnostic test to identify carriers of the BLAD gene. If a bull that has the BLAD gene is mated with a cow carrying the same gene, one in four of their offspring will inherit two copies of the gene and usually will die by seven months of age. ARS made the test available to the National Association of Animal Breeders and the Holstein Association to check 20,000 Holsteins, mostly bulls, worldwide. Bulls that were identified as carriers of the BLAD gene were removed from herds. Positive test results in purebred U.S. Holstein cattle have dropped from 23 percent of bulls tested in 1989 to zero.

Metabolic Diseases and Immunology, Ames, IA

Marcus E. Kehrli, (515) 239-8462

An enzyme produced naturally by *Trichuris suis*—the swine whipworm—could open the door to controlling that internal parasite in pigs. ARS research indicates the enzyme, called a thiol protease, plays a significant role in the worms' ability to digest and absorb nutrients. Blocking the action of the enzyme with a chemical could be an effective way to control the parasites. Swine whipworms cause weight loss, anemia and diarrhea in pigs, and can kill the animal if the infection is heavy. The worms form lesions in the surface of the intestinal lining of infected pigs. This allows bacteria to invade underlying tissues. Whipworms aren't completely controlled by commercially available worming medicines.

Parasite Biology and Epidemiology Laboratory,
Beltsville, MD

Dolores E. Hill, (301) 504-8444

ARS parasitologists are using a fingerprint-like pattern of surface cuticular ridges to revolutionize the identification of the most important parasitic pest of cattle and sheep. The new method has made it possible

to identify individual specimens of the large stomach worm of cattle and sheep as separate species—ending a century-long controversy. In the southeastern United States, these parasites are called “the bankrupt worm” because of the severe losses of young animals, cost of treatment and loss of contaminated pasture. The pattern of ridges on the outer surface of the worm, called the synlophe, also has been used by ARS parasitologists to develop identification keys to the highly pathogenic species of medium stomach worms in cattle and sheep. Recognizing the worms in cattle and sheep as separate species will improve control measures for these parasites. The method also can be used to recognize exotic species of both groups imported into the United States with exotic hosts.

*Biosystematic Parasitology Laboratory,
Beltsville, MD
J. Ralph Lichtenfels, (301) 504-8530*

Soil, Water and Air Quality

Winter wheat yields are better in dry years on the southeastern Coastal Plains when fields are deep tilled—chiseling under the surface, but not plowing up the soil. That’s done before planting to loosen underground soil while barely disturbing the surface. Yields are up to 25 percent higher than for wheat planted on fully plowed fields. One reason for this yield increase: Leaving surface residues not only impedes erosion, but helps conserve water in soil pores. ARS scientists made this finding in 1994-95 field studies comparing winter wheat yields planted after a summer soybean crop on sandy, coastal plain soils. On one field, researchers plowed under soybean plant residues, while on the other field they left the soybean residue on the surface. On both plots, they planted wheat after deep tilling 14 inches below the surface. A Paratill was used to break up the underground soil while leaving harvested soybean plants and earlier crop residues on the surface. During the rainy 1994 season, winter wheat yields were 67 bushels an acre in both fields. But, during the 1995 drought season, winter wheat yields were 62 bushels an acre on deep-tilled fields where soybean residues were left undisturbed, compared to 50 bushels an acre on the fields where surface residue was plowed under.

*Coastal Plain Soil, Water and Plant Research,
Florence, SC
Philip J. Bauer, (803) 662-5203*

Water quality in the Mississippi Delta is being monitored to assess the effects of farm management practices on the region’s ecological health and long-term productivity. Monitoring sites have been set up at

three Mississippi oxbow lakes—crescent-shaped bodies of water formed from an old remnant of a stream. They are the latest additions to the federal Management Systems Evaluation (MESA) project, a long-term research program to keep tabs on the nation’s ground and surface water quality. ARS scientists are surveying the lakes and establishing automated water quality and runoff measuring and sampling stations. They are cooperating with researchers at Mississippi State University and the University of Mississippi as well as other federal, state, and local agencies.

*National Sedimentation Laboratory, Oxford, MS
John Schreiber, (601) 232-2925*

Egeria has been brought under control on a five-acre test area in northern California, where this aquatic weed threatens the state’s water delivery system. The weed clogs waterways, stopping the flow of water. If it spreads, it could impede water flow to farms and cities. Scientists can stop the weed by applying a commercially registered herbicide every three to five weeks from April through the end of September. They now are looking at more effective herbicides and cultural practices, as well as ways to apply them with underwater injector lines. Currently used power boats are expensive, raising the cost to several hundred thousand dollars for large control efforts.

*Aquatic Weeds Control Research, Davis, CA
Lars W. Anderson, (916) 752-6260*

Inexpensive vegetable cooking oils might be used to clean groundwater contaminated with nitrogen fertilizer. When not used with care, the fertilizer can move downward through soil. Natural soil microbes “eat” the nitrate in the fertilizer and convert it to harmless nitrogen gas. ARS scientists have found that oils squeezed from corn or soybeans provide a carbon source that increases the numbers of helpful microorganisms. Scientists envision injecting oil under pressure into the base of existing wells. It would become trapped in soil particles and form a filter. When water is pumped, it would pass through this natural filter, becoming cleansed. Or, above-ground troughs filled with sand and gravel might be used to treat pumped groundwater. This would eliminate a potential health threat to humans and animals. The researchers have decontaminated water containing 200 times the maximum permissible nitrate level for U.S. drinking water. The new method is simpler and cheaper than approaches that could be designed to intercept and treat nitrate-contaminated water before it reaches groundwater.

*Soil-Plant Nutrient Research, Fort Collins, CO
William J. Hunter, (970) 498-4208*

IPM/Biological Control

The health of lab-reared Mediterranean fruit flies—and their human handlers—is protected better with refinements ARS scientists devised for the flies' food. Billions of sexually sterile medflies are raised each year in labs in Hawaii and elsewhere to combat medfly invasions in states such as California. When sterile male flies mate with their wild female counterparts, no fertile offspring result. The population dies out. But, in their mush-like meals of wheat bran, sugar, yeast and water, the flies need healthful acids. In the past, as the food fermented, natural bacteria would produce acetic acid. But volatiles from this acid can exceed federal standards for worker safety and irritate the eyes. Scientists found that adding two antibiotics and pasteurizing the food helps hold down the acetic-acid-making bacteria and other unwanted microorganisms. And incorporating some citric acid meets the flies' acid needs. Tests with more than 900 million medflies showed that keeping their rations acid—pH 4.0 to 5.0—boosts size and survival about 15 to 20 percent. Though the idea of adjusting pH to increase medfly survival in the lab isn't new, the ARS studies apparently are the most extensive to date to explore pH options for the food that is used at medfly-rearing labs in Hawaii.

*Tropical Fruit and Vegetable Research Laboratory,
Hilo, HI*

Eric B. Jang, (808) 959-4340

Stored-grain pests may meet their match in high-power microwaves. ARS scientists have teamed with the Oak Ridge National Lab at Oak Ridge, TN, and Micro-Grain, Inc. of Clinton, WI, to demonstrate the use of microwaves against insects. In preliminary ARS studies two years ago, microwave energy killed 94 percent of the maize weevil, *Sitophilus zeamais*, in samples of soft white wheat. Samples of the wheat were placed in a microwave at a temperature of 122 degrees F. Heating up to 145 degrees F kills all the insects, but doesn't cook the grain. Micro-Grain will make metal applicators to separate and apply microwave energy to the grain as it flows from bucket elevators, through metal pipes and into storage. If the technology is successful, the company could employ as many as 40 people to manufacture the applicators. Micro-Grain, Inc., is seeking a patent on the applicator design.

Stored-Product Insects Research, Madison, WI

Wendell E. Burkholder, (608) 262-3795

Manna scale insects that fed the Israelites in the Old Testament may become the newest biological control of an exotic tree that invaded western states.

Saltcedar (*Tamarix*) infests and clogs river beds. It has

become one of the worst weeds along western streams where it was planted in the 1800s as an ornamental and to stabilize stream banks. Manna is honeydew produced by five species of *Trabutina* scale, a beneficial sap sucking insect from the southern regions around the Dead Sea. Manna scale insect and a leaf beetle, *Diorhabda elongata*, from China that eats saltcedar leaves have potential as natural controls of the tree. ARS scientists tested the beneficial insects at the University of Tel Aviv, Israel; the ARS European Biological Control Laboratory in Montpellier, France, and at the ARS Quarantine Facility at Temple, TX. Studies indicate the insects could be alternatives to herbicides and mechanical methods that suppress saltcedar but also kill native vegetation. By the summer of 1996, scientists expect to release manna scale egg sacs along the lower Gila River in Arizona and along the Rio Grande River in western Texas.

*Grassland, Soil and Water Research Laboratory,
Temple, TX*

Jack DeLoach, (817) 770-6531

Human Nutrition

Older men don't burn as many calories after overeating as their younger counterparts, so they may have to compensate by doing a little more exercise—such as taking a walk after dinner. Earlier studies have implied that aging hampered the body's ability to increase its resting metabolic rate—the energy needed to keep the resting body functioning—and thus 'waste' the extra calories. So researchers tested the thesis by feeding a small group of men in their 60s and 70s and another group in their 20s an extra 1,000 calories a day for three weeks. Both age groups had an increase in metabolic rate, but the older group had a smaller increase, the researchers reported in the *Journal of Gerontology*. The difference amounted to about 87 calories a day that the older group would store as fat if they didn't increase their exercise. That adds up to an extra 2.2 pounds per year or 22 pounds a decade, the researchers estimate. On any given day, people may fluctuate between eating 500 to 1,000 calories more or less than needed. So the men's ability to 'save' calories in times of scarcity was also tested by giving them 750 calories less than needed to maintain weight for three weeks. In this case, both groups decreased their metabolic rate about the same. Earlier, the researchers reported that the young group automatically reduced their calorie intake after the overeating period, whereas the older group continued to overeat. Taken together, the findings help explain why body fat creeps up in older men.

*Jean Mayer USDA Human Nutrition Research Center
on Aging at Tufts, Boston, MA*

Susan Roberts/Paul Fuss, (617) 556-3237

A genetic variation that may increase the risk of osteoporosis can be counteracted by raising calcium intake, according to a study of 60 women. When the intake was 1,500 milligrams a day, the 26 women who had the genetic variant absorbed just as much calcium as the 34 women with a normal gene. But when calcium intake was reduced to less than 300 mg/day, those with the variant absorbed significantly less. That's because intestinal cells have to actively pump in the calcium when the supply is scarce rather than letting it seep in when there's plenty. And active absorption requires vitamin D and a functional vitamin D receptor—a molecule that sits at the surface of cells and hooks up with the vitamin to activate the process. The "osteoporosis gene," discovered in 1994 by an Australian scientist, is a variation of the vitamin D receptor gene, which apparently renders the vitamin D receptor less efficient. The findings are consistent with earlier results in this laboratory showing that the association between the "osteoporosis gene" and hip bone loss depended on the calcium intake level. And it may explain why some studies have seen a relationship between the genetic variation and bone mineral density while others have not.

*Jean Mayer USDA Human Nutrition Research Center on Aging at Tufts, Boston, MA
Bess Dawson-Hughes, (617) 556-3064*

Industrial (Non-Food) Products

A new refining process for soy protein yields a protein so pure it rivals synthetic proteins used by the pharmaceutical industry. That same protein also has great food potential—it could be whipped, for example, into fat-free desert topping. The industry standard for concentrated soybean protein is about 60 percent purity. ARS scientists worked out the new process that results in a snow-white powder of nearly 100 percent pure protein. Researchers have been using a high-protein soybean called Prolina to test the process. Currently, Prolina is being tested by soybean farmers who can earn premiums for the protein content of their seeds. Prolina is high in 11 proteins, which makes it easier to whip the protein or turn it into cheese substitutes and other fat-free foods. Also, the refining process can produce amino acids with such purity that they might supplement animal feeds or provide the pharmaceutical industry with an inexpensive alternative to synthetic amino acids.

*Soybean and Nitrogen Fixation Research,
Raleigh, NC
Prachuab Kwanyuen, (919) 515-2734*

A new antibacterial agent for cotton products uses peroxide to kill microbes and magnesium and retain

the antibacterial properties for over 50 washes. ARS scientists developed the antibacterial agent that makes cotton more resistant to odor-causing germs. Normally, industries such as diaper services use a chemical wash every time they clean diapers to impart antibacterial properties. But now, the odor resistance can be "built in." Other potential markets for the antibacterial treatment—which is available for commercial licensing—could include athletic wear such as socks or shoe insoles. (PATENT APPLICATION 08/580,230)

*Southern Regional Research Center, New Orleans, LA
Tyrone L. Vigo, (504) 286-4407*

Flavors, fragrances or medicines may soon be encapsulated in beads of starch made by a new process. The compounds could be easily released when the starch contacts water, such as when soup mix is added to boiling water or when a person drinks water to swallow a pill. Scientists call the biodegradable beads "microcellular foam." The beads are rigid white spheres ranging from the size of a salt grain to that of a peppercorn. With a network of tiny pores and cells, the beads quickly absorb flavorants or other compounds. Other potential uses include dispensing pesticides or absorbing spilled chemicals. Starch is already used to encapsulate food flavorants. But one commonly used method requires heating the mixture. This can cause flavor loss. The ARS approach doesn't require heating. And, it may prove less expensive than a different technique that relies on starch-derived molecules called cyclodextrin polymers. ARS scientists are experimenting with wheat and corn starches and say the process might also apply to starch from potatoes, peas, tapioca and other grain and vegetable crops. (PATENT APPLICATION 08/499,592)

*Cereal Product Utilization Research, Albany, CA
Gregory M. Glenn/Donald A. Stern, (510) 559-5677*

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Quarterly Report

of Selected Research Projects

April 1 to June 30, 1996

United States
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Agricultural
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Into the Marketplace

A naturally occurring virus that kills more than a dozen different kinds of crop-eating caterpillars may be marketed as a bioinsecticide in a few years. Two ARS researchers—now retired—discovered the celery looper virus and received a patent in 1990. Now, biosys, Inc., of Columbia, MD, has registered the virus with the U.S. Environmental Protection Agency. The firm has signed an agreement with Zeneca Agrochemicals, Surrey, England, for worldwide commercialization of new insecticide products based on the microorganism. The virus quickly kills caterpillars that accidentally eat virus particles while munching on the plants. The microorganism doesn't target people, pets or wildlife. It fells its namesake, the celery looper caterpillar, and

Contact the scientists who are listed for further information on each research project. For general questions about this report, contact Sean Adams or Lisa Spurlock, ARS Information, 6303 Ivy Lane, 4th Floor, Greenbelt, MD 20770, (301) 344-2723/2824, sadams@asrr.arsusda.gov or lspurloc@asrr.arsusda.gov

Items marked with the word PATENT are being patented by ARS. For more information on patents, CRADAs and patent licenses, contact C. Andrew Watkins, National Patent Program, Bldg. 005, Rm. 416, BARC-West, Beltsville, MD 20705, (301) 504-5734. Questions about a company's product and/or research should be directed to the company itself.

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other cotton and vegetable pests including cabbage looper, tomato and tobacco hornworm, cotton bollworm (also known as corn earworm and tomato fruitworm), beet armyworm, diamondback moth, and pink bollworm. USDA has granted licenses for the celery looper virus to biosys and to Sandoz Agro, Inc., Des Plaines, IL. Both companies are continuing outdoor tests of the virus this summer.

*Horticultural Crops Research Laboratory,
Fresno, CA*

Patrick V. Vail, (209) 453-3000

About 13,000 summaries of ARS research findings can now be searched in the agency's TEKTRAN database. It's been available on the World Wide Web since April. TEKTRAN is a new online window to ARS research labs—and to farm, food, environmental, and industrial technologies and products of the future. Besides the summaries, the WWW site offers links for investigating new ARS technologies available for licensing. ARS adds new summaries to TEKTRAN after scientists submit manuscripts to scientific journals. Summaries are removed after three years. Browsers can conduct a full-text search of the summaries, including titles, keywords, and author information. They can also search by categories such as nutrition, germplasm, pests, and soil management. Some summaries are not posted—to safeguard intellectual property rights of ARS inventors and cooperators. The Internet version of TEKTRAN was developed by the Technology Transfer Information Center (TTIC) of ARS' National Agricultural Library in cooperation with ARS' Office of Technology Transfer (OTT) and National Program Staff. ARS is steadily improving TEKTRAN's scope and convenience. The address is: <http://www.nal.usda.gov/ttic/tektran/tektran.html>.

Office of Technology Transfer, Beltsville, MD

C. Andrew Watkins, (301) 504-5734

National Agricultural Library, Beltsville, MD

Kate Hayes, (301) 504-6875

Cooperative Research and Development Agreements

...With Alpharma, Inc., of Bellevue, WA, to help develop a vaccine against *columnaris* disease of channel catfish grown in ponds. ARS researchers will pinpoint crucial antigens for possible use as a vaccine. Antigens are proteins produced naturally by the patho-

gen that cause a fish's immune system to produce antibodies. *Columnaris* is a leading disease of channel catfish, estimated to cause losses of \$20 million to \$30 million annually. Since treatment options are limited, a vaccine is needed to prevent the disease from gaining a foothold in catfish ponds.

ARS Contact: Phillip H. Klesius, Fish Diseases and Parasites Research Laboratory, Auburn, AL, (334) 887-3741

...With Pioneer Hi-Bred International of Johnston, IA, to study the genetics behind some corn roots' ability to probe deeper in the soil. Called "corn root gravitropic response," this trait is especially important when growing conditions are relatively dry and plants must penetrate deeper to reach available soil moisture. Pioneer Hi-Bred will provide seeds of corn lines that may have roots with a propensity to grow farther down in the soil. ARS researchers will determine if the ability to grow deeper is an easily inherited trait—information that corn breeders can use in developing corn lines that are more drought-tolerant.

ARS Contact: Richard W. Zobel, Plant, Soil and Nutrition Research, Ithaca, NY, (607) 255-4573

...With Ciba Crop Protection of Greensboro, NC, to genetically engineer bacterial strains to combat diseases in grain, cotton and vegetable crops. These strains would produce an antibiotic, called 2,4-diacetylphloroglucinol, or Phl. ARS scientists identified genetic elements that enable certain species of *Pseudomonas* bacteria to make the Phl compound. It suppresses fungi that cause take-all, one of the world's worst wheat diseases. Using molecular techniques, the ARS scientists implanted Phl-making genes into bacteria that normally could not make Phl. In the lab, the engineered bacteria produced at least as much Phl as the *Pseudomonas* species that were sources of the inserted genes. ARS is providing bacterial genes that Ciba Crop Protection scientists will insert into additional bacterial strains. The company will test them for activity against a variety of diseases in cotton and vegetable crops. ARS will test some of Ciba's strains against take-all and other root diseases of wheat and barley. (PATENT APPLICATION 08/494,907)

ARS Contact: Linda S. Thomashow, Root Disease and Biological Control Research Unit, Pullman, WA, (509) 335-0930

Computer Systems and Models

A remote sensing system developed by ARS is the scientific launch pad for a four-satellite commercial network. It is expected to reveal such details as too

much or too little soil moisture; nutrient deficiency in a crop; and emerging weed, insect and disease outbreaks. Planned for earth orbit in 1999, the space system is to be built and launched by RESOURCE21, Inc., of Denver, CO. It would be the first commercial system to deliver data, up to twice weekly, to farmers within 24 hours of being obtained from satellites. In addition, the National Aeronautics and Space Administration is considering switching to the RESOURCE21 space system from its Landsat system. ARS researchers in Texas have since 1985 been assembling and testing approaches for using remote sensing to monitor crop and environmental conditions. The original ARS system was based on video recorders, equipped with three special light filters. RESOURCE21 today uses a very similar system—but with digital cameras—in an airplane-based prototype of the future space system. Data are supplied by computer linkup to growers in several states. They generate maps and graphs that show the location and extent of potential problems. RESOURCE21 partners include Agrium Ltd., Boeing Commercial Space Company, Farmland Industries, Inc., General Dynamics Electronics Systems, Institute for Technology Development and Pioneer Hi-Bred International.

*Remote Sensing Research, Weslaco, TX
Jim Everitt, (210) 969-4824*

Genetic Resources

Answering the call of plant specialists, ARS' National Plant Germplasm System (NPGS) distributed more than 117,000 seeds, cuttings and other forms of plant germplasm in 1995—30 percent overseas. And, from 1990 through 1995, the NPGS distributed 886,704 germplasm samples to scientists and breeders in 149 countries—including 11 countries in South America, 20 in the Caribbean and Central America, 34 in Africa, 15 in Western Asia, 16 in Europe, 11 in the South Pacific Islands, 12 in the Southeast Asia Rim, and four in the China Sphere. More than 200,000 of those distributions were from wild or "landrace" plants that may contain rare, valuable genes of interest to breeders—such as genes for drought resistance or higher yields. The crops ranged from the popular wheat, corn, potatoes and tomatoes to the lesser-distributed native American pecan. The NPGS stores seeds, cuttings and other forms of germplasm that contain each plant's unique genes—making the system a "genetic bank" for the world's plant diversity. During 1990-95, the system also received 28,242 germplasm samples from 88 countries—where, in some cases, the germplasm came from plants that were threatened by development.

*National Genetic Resources Program, Beltsville, MD
Henry Shands, (301) 504-5059*

Digital cameras now record when seeds germinate—and how fast and long the tiny roots grow. The data will help seed-bank scientists, who need to easily and quickly identify seed in danger of dying in storage. All seeds lose vigor during extended storage; plants must be regrown periodically to refresh the seed supplies. Root length is one key sign of vigor, but the current test—done by hand—is expensive and time-consuming. The new approach uses a germination chamber that contains a rotating carousel of 50 moist boards covered with blotter paper. Seeds are placed on the boards to germinate. As the carousel turns, once per hour, a digital camera records images of all the seeds' germination and root growth. Scientists say plant breeders could use the system to select plants with fastest growing roots and greatest vigor. This technique also has significant potential for the seed trade industry which seeks to market high-vigor seed.

*National Seed Storage Laboratory, Fort Collins, CO
Phillip C. Stanwood, (970) 495-3209*

Crop Productivity

Two new American elms with high levels of tolerance to the fungus that causes Dutch elm disease could restore the American elm to the Main Street USA of earlier days. Since the 1930's, an estimated 90 percent of American elms have died—victims of a fungus, *Ophiostoma ulmi*, that wiped out 77 million American elms. For over 20 years, ARS scientists worked to develop 'Valley Forge' and 'New Harmony' elms by screening thousands of American elms and inoculating them with the culprit fungus, eventually narrowing the selection to these final two trees. Compared to other American elms, the two new trees have significantly lower foliar symptoms and crown die-back, even after being intensively inoculated with the Dutch elm fungus. Although neither tree is completely immune to the disease, 'Valley Forge' is the most tolerant, while 'New Harmony' is among the three most tolerant of all the trees the researchers examined. The two elm varieties will be the first commercially available, Dutch elm-tolerant American elm trees. Over a hundred rooted cuttings of 'Valley Forge' and 'New Harmony' were distributed over the last two years to tree nurseries, experiment stations and arboreta. Wholesale nurseries will propagate the trees for sale by late 1997 or 1998; retail nurseries should have them in 1999.

*U.S. National Arboretum, Glenn Dale Laboratory,
Washington, DC*

Alden M. Townsend, (301) 344-4175

Four new watermelon lines that have genetic resistance to a viral disease are now available to breeders.

ARS scientists screened 670 germplasm accessions to find the four resistant lines, which came from plants originally from the African countries of Zaire and Nigeria. The new lines provide rare sources of resistance to watermelon mosaic virus, which attacks watermelons and other cucurbits around the world. To determine resistance, scientists initially screened watermelon germplasm lines against a Florida strain of the virus in the greenhouse and field studies. Then, four of the most resistant lines were tested in the greenhouse against strains from Florida, Arizona, California, New York, Israel and Italy. Limited quantities of seed are available only to public and private breeders who must cross the lines with commercial types to develop new hybrids for public sale.

*Plant Genetic Conservation Resources, Griffin, GA
A. Graves Gillaspie Jr., (770) 412-4777*

Cotton breeders have 10 more ARS lines they can use to develop new commercial varieties of top-quality Pima cotton. High yields and long, strong fibers are among the agronomic benefits in the new cotton lines. Breeders can use the new ARS lines to fine-tune varieties for specific climates and soil types in the Southwest. An additional two lines provide fiber length and strength, previously unavailable in a heat-tolerant, early maturing cotton. Pima continues to be popular with western growers because its superior fiber brings higher prices than upland cotton. Upland cotton grows on about 15 million acres; Pima, on 180,000 acres. ARS scientists developed the new Pima lines in cooperation with the University of Arizona at Tucson.

*Western Cotton Research Laboratory, Phoenix, AZ
Richard G. Percy, (602) 379-4221*

A new long-grain, semi-dwarf rice called Jefferson resists two serious fungal diseases and offers high yield, excellent cooking properties and other desirable traits to boot. A limited supply of seed is available to rice farmers and breeders from the ARS researchers who developed, tested and released the new variety. Jefferson is a cross between Roscmont, a conventional long-grain cultivar, and B 82-761, a germplasm breeding line. Three different genes for fungus resistance protect Jefferson rice plants from *Pyricularia grisea*, the fungus that causes blast, and *Rhizoctonia solani*, which causes sheath blight. Both diseases are prevalent in Texas, Arkansas and other rice-growing states in the South. When challenged with the fungi in 1994-95 field tests, Jefferson yielded 81 percent of the average 2,506-pound-per-acre yield expected when the fungi are not present. Two commercial varieties, Cypress and Lemont, retained only about 60 percent of their yields. Jefferson matures in about 125 days. A sturdy stem keeps the plant from toppling and spilling its grain onto

the ground where it can't be harvested. Long and thick, the rice grains have an average 21 percent amylose, a starch component that helps reduce stickiness and softness.

*Rice Research Unit, Beaumont, TX
Anna M. McClung, (409) 752-5221*

New, short rice plants now available to breeders can survive flooding while delivering high grain yields. The new experimental rice plants may turn out to be a boon to many Asian countries—and to U.S. farmers, who grow rice mostly for export. Asian farmers currently must grow lower-yielding tall rice varieties that survive by keeping their grain heads above flood waters. But ARS scientists crossbred tall and short varieties to combine their valuable traits into one short, high-yielding variety and have located the gene that confers submergence tolerance. Breeders can develop commercial varieties from the new plants. In field tests in the Philippines, the plants produced about five tons per acre—about 20 to 40 percent more than tall Asian varieties. Another benefit of the new rice might be weed control, because fields planted in short rice can be flooded until the weeds drown. Annually, Asia produces about 90 percent of the 500 million tons of rough rice produced worldwide. While this dwarfs the seven to nine million tons grown in this country, the U.S. accounts for about 20 percent of all rice sold in international markets.

*Crops Pathology and Genetics Research Unit,
Davis, CA
David J. Mackill, (916) 752-5966*

A new test will help breeders find rice plants that have genes for greater resistance to zinc deficiency—which costs farmers millions of dollars in lost yields annually. Rice suffers from zinc deficiency in this country and abroad—including China, India, Japan and the Philippines—even though the soils contain adequate zinc for other crops. The deficiency occurs because sulfides formed in rice paddies make zinc unavailable. Yield loss to zinc deficiency costs farmers millions of dollars each year. ARS scientists developed the test in which rice seedlings grow in a special nutrient solution that lowers zinc availability, while providing all other nutrients needed for normal growth. By supplying all needed nutrients, except the one being tested for, the solution avoids the risk of creating a deficiency of another nutrient that could cause confusing results. Field tests have borne out the lab results.

*Environmental Chemistry Laboratory, Beltsville, MD
Rufus Chaney, (301) 504-8324*

New oat varieties could someday make it possible to grow winter oats in cold weather states—and in less

frigid states where a hard freeze won't spoil a farmer's crop. ARS and cooperating researchers are testing domestic and foreign varieties to discover which ones hold up well in a broad range of winter weather, especially as a livestock feed. Some current domestic varieties, for example, do well with wet winter conditions, but die out in dry cold. A wild blue-green oat, found in Algeria and Turkey, is showing promise of winter hardiness. Still to be answered: whether acceptable yields can be produced from crossing this oat with domestic varieties.

*Raleigh Research Unit, Raleigh, NC
David Livingston, (919) 515-5834*

Orange trees growing in air with 75 percent more carbon dioxide (CO₂) than today's level have produced nearly two and one half times more fruit and slightly more vitamin C in the juice. Researchers want to learn how rising CO₂ levels in the future could affect crop productivity. For the experiment, the sour orange trees grow in outdoor open-topped chambers having a CO₂ concentration most scientists agree will occur about the middle of the 21st century. The CO₂-enriched trees have nearly twice the trunk and branch volumes compared to trees in chambers that don't get extra CO₂. The experiment, now in its ninth year, is the world's longest of its kind.

*U.S. Water Conservation Laboratory, Phoenix, AZ
Sherwood B. Idso, (602) 379-4356*

A soybean strain that overcomes the inverse relationship between seed yield and seed protein content has been developed—a first in soybean breeding. Until now, developing soybean varieties with both high yields and high protein has been difficult, because as seed yield increases, protein tends to decrease. Using conventional breeding techniques, ARS scientists incorporated the exceptionally high seed protein (49.8 percent) of the low-yielding variety Pando into a plant similar to Cutler 71. Cutler 71 has 40.8 percent protein and yielded about 36 bushels per acre (bu/a) in performance tests. The new strain combines Cutler's yield with Pando's high seed protein. The new soybean strain, evaluated for maturity date, seed protein, oil content and other traits, had an average protein content of 47.2 percent and had significantly higher yields (42 bu/a) than Cutler. This strain also had 17.4 percent oil content in the seed—significantly more than the 14.8 percent in Pando but less than the 20.4 percent in Cutler 71. Soybeans are grown for seed oil and for the high-protein meal that is left after the oil is extracted.

*Crop Production and Pathology Research, West
Lafayette, IN
Jim Wilcox, (317) 494-8074*

An improved bacteria for inoculating soybeans could bring farmers an additional \$500 million annually if used on all U.S. soybean acreage. The new strain of *Bradyrhizobium japonicum* increases production by 3.4 percent, according to 28 university yield tests. Urbana Laboratories, St. Joseph, MO, sold enough of the patented strain in 1995 to treat 227,000 acres, and sold one-third more in 1996. Some 10 to 12 million acres of soybeans are inoculated each year. The new inoculant, a product of conventional bacterial genetics by ARS scientists, resulted in plants that develop 25 percent more root nodules. Inside these nodules, bacteria live and convert nitrogen from the air into a form the plants can use.

*Soybean and Alfalfa Research Laboratory,
Beltsville, MD*

L. David Kuykendall, (301) 504-5736

*Soil, Plant and Nutrient Research Unit, Fort
Collins, CO*

William J. Hunter, (970) 498-4208

Electrical changes in soybean roots seem to protect the plant from stress, such as excess oxygen. As a result, bacteria living in nodules on the roots are still able to fix nitrogen. Nodules have to maintain just the right amount of oxygen. Too much or too little harms the bacteria's ability to supply nitrogen from the air to the plant. No one is sure how nodules regulate their oxygen supply, but ARS researchers discovered that electrical changes are linked to changes in oxygen supply in soybean, alfalfa, clover and birdsfoot trefoil nodules under oxygen stress. This discovery could eventually lead to improvements in stress tolerance of root nodules, allowing them to continue supplying the crop with nitrogen even under moderate drought or after cattle grazing. The electrical response to stress was discovered after excess oxygen was pumped around the nodules. To the researchers' surprise, the negative electrical charge on the inside walls of the nodules' cells dropped. That caused the nodules to counteract the oxygen stress by letting in less oxygen. Future tests may determine whether the change in electrical charge accompanies stresses other than excess oxygen.

*Appalachian Soil and Water Conservation Research
Laboratory, Beckley, WV*

Thomas B. Kinraide, (304) 252-6426

R. Ford Denison (formerly with ARS), (916) 752-9688

Peanut breeders can choose between four varieties to get the best flavor to go along with peanut size, based on a 12-year study by ARS scientists. Over 200 varieties and breeding lines were analyzed for flavor traits. Results: Dixie Giant, Spanish 18-38 and Small Spanish White varieties 3x-1 and 3x-2, were consistent in contributing to enhanced flavor traits. A trained taste

panel at North Carolina State University evaluated peanut flavor for the various varieties and their offspring. Plant samples came from Florida, Georgia, Oklahoma, Texas and Virginia.

*Market Quality and Handling Research, Raleigh, NC
Harold E. Pattee, (919) 515-6745*

Crop Diseases and Pests

Fire ants not only build mounds in farmers' fields, but they also are taking a bite out of farmers' seeds. ARS researchers conducting field tests on conservation tillage in Texas saw crop germination plummet. At first, the scientists suspected that experimental planting equipment was damaging seeds. But when they dug up seeds for inspection, they exposed fire ants devouring the tender, tasty heart of the seeds. Subsequent tests have shown the ants can damage dry wheat seed at a rate of about 11 percent per day, capable of wiping out the entire planting in 10 days' time. Damage on dry corn seed runs about six percent per day, grain sorghum about seven percent daily, soybeans about one percent daily and cotton 0.5 percent per day. One possible deterrent to the foraging fire ants: liquid starter fertilizer. When researchers used the fertilizer at rates of about 100 pounds per acre, plants in the field emerged without fire ant damage. In subsequent greenhouse tests, the fertilizer wasn't as effective, but more field tests are planned this year.

*Natural Resources Systems Research, Temple, TX
John E. Morrison, (817) 770-6507*

Florida-grown sweet potatoes can be given a light dose of irradiation that controls the sweet potato weevil, according to ARS researchers. Sweet potatoes are an important crop in the southeastern United States, and an excellent market awaits in areas where the weevil is not present. But shipment to potato weevil-free areas such as California is prohibited unless the product has been fumigated with methyl bromide, the postharvest quarantine treatment approved to kill this pest. But there's a catch: Sweet potatoes develop fungal decay from methyl bromide, which is scheduled to be phased out by the year 2001. Irradiation, used as a quarantine treatment for potato weevils, leaves no residue and does not adversely affect the taste or appearance of the sweet potatoes, even after they've been cooked.

*Subtropical Horticulture Research Station, Miami, FL
Jennifer Sharp, (305) 238-9321*

New diagnostic tests can positively identify two types of bacteria that attack strawberries and citrus. The tests examine the bacteria's genetic makeup to unmask harmful strains of *Xanthomonas fragariae*, which causes

angular leaf spot disease in strawberries, and *Xylella fastidiosa*, the culprit behind citrus variegated chlorosis (CVC) and other economically important plant diseases. Angular leaf spot is found throughout the United States, including California and Florida, the major U.S. producers of strawberries, as well as in other strawberry-growing areas of the world. It can wipe out 80 percent of a strawberry crop. The only control is to catch the disease at the nursery level and destroy plants. The new DNA test will reveal the presence of the bacteria even before symptoms appear in infected plants. Likewise, there is no known chemical control for CVC, which has not yet arrived in the United States but is in Brazil and northern Argentina. The new test differentiates between strains of the bacterium that are already in the United States and the strains that cause CVC.

*Fruit Laboratory, Beltsville, MD
John Hartung, (301) 504-7572*

Bioengineered tomato plants with a one-two punch against cucumber mosaic virus (CMV) are being field tested outdoors this summer. ARS and collaborating scientists who engineered the tomatoes want to see if the plants can withstand CMV more effectively—and without chemical pesticides now used. The new tomatoes' knock-out combo are a natural molecular parasite and a gene for CMV's protective coat. Currently, growers in the United States and abroad spray insecticides to kill aphids that transmit virus from plant to plant. This doesn't always prevent disease from spreading. And, breeders have had little success at incorporating into domestic varieties the natural virus resistance found in some wild relatives of tomato. But a gene for the virus' protein coat may help "vaccinate" tomato plants against the viral infection. The plants' second new genetic defense is a parasite known as a viral satellite. Little more than a naked strip of genetic material, the satellite nevertheless is able to filch for its own use a key enzyme needed by the virus. This retards the virus' ability to multiply and cause disease. Neither the coat protein nor the satellite is harmful to humans, animals or insects.

*Molecular Plant Pathology Laboratory, Beltsville, MD
Marie E. Tousignant, (301) 504-6485*

All rice plants are not created equal when it comes to naturally fending off weeds. In ARS field tests, the Philippine rice variety PI 312777 and two Chinese varieties—Guichow and Teqing—crowded out up to 90 percent of weeds without help from herbicides. That's compared to the U.S. rice variety Lemont, which kept out about 60 percent of weeds, and U.S. varieties Kaybonnet, Starbonnet and Cypress, which slightly outperformed Lemont. The rice plants were competing against the common weeds barnyardgrass and bearded sprangletop for space, water, sunlight and nutrients. Rice quality

from the foreign lines usually doesn't measure up to U.S. standards. But, their weed-fighting characteristics could be incorporated into more desirable commercial varieties through crossbreeding, reducing the reliance on chemical weapons against weeds.

*National Rice Germplasm Evaluation and
Enhancement Center, Stuttgart, AR
David R. Gealy, (501) 673-2661*

Scientists have developed ways for farmers to control disease- and insect-carrying volunteer potatoes.

Such potatoes escape harvesting equipment in the fall, sprout the next growing season and become a weed in subsequent crops like corn, alfalfa, onions and carrots. While the volunteer plants compete for water, their real threat is their role as carriers of diseases and insects. They can harbor late blight, early blight, potato leaf roll, potato virus Y, green peach aphids, Colorado potato beetles, and nematodes. Strategies the scientists recommend include: maintaining and adjusting harvesting equipment so few potatoes are left in fields; planting varieties that mature early; planting crops like alfalfa, winter wheat, or corn that are strong competitors; and selecting correct herbicides. From 43,000 to 110,000 tubers per acre remain after harvest. Scientists say up to five percent of these escapees often survive freezing temperatures in the potato-producing sections of central Washington and sprout to become problem plants. Tubers survive in moist soil at 28 degrees F and in dry soil at 25 degrees F.

*Irrigated Agriculture Research and Extension
Center, Prosser, WA*

Rick A. Boydston/Marcus D. Seymour, (509) 786-3454

IPM/Biological Control

Two decades of persistence by ARS scientists have renewed attempts to establish a small Asian wasp—a natural enemy of gypsy moths—in the United States. Gypsy moth caterpillars are the worst insect pests of forest and shade trees in the East. But after an egg of a *Rogas indiscretus* wasp hatches inside the caterpillar, the young wasp eats the pest's insides. One female wasp can lay 200 or more eggs. From 1968 to 1977, scientists released about 30,000 *Rogas* wasps that all seemed to vanish. But in 1994, the last year of a 20-year monitoring study, ARS researchers in Maryland found several *Rogas* cocoons. Their discovery led to the first new *Rogas* shipment in decades—about 200 cocoons collected last June in India and shipped to an ARS lab in Delaware. There, several thousand wasps will be reared for releases planned in Maryland, Michigan and Pennsylvania in 1997. Gypsy moths,

originally from Europe, have spread to occupy a region from New England west to Michigan and south to North Carolina. ARS and cooperating scientists have imported and test-released more than 50 natural enemies of the moth. About a dozen are known to have become established. Others may be here but, like *Rogas*, have so far eluded detection.

Insect Biocontrol Laboratory, Beltsville, MD
Robert F.W. Schroder/Ann M. Sidor, (301) 504-8369
Beneficial Insects Introduction Research Laboratory,
Newark, DE
Roger W. Fuester, (302) 731-7330

"Seeding" predatory beetles in wooded areas could help rein in gypsy moths, according to scientists who conducted field tests in three states. One *Calosoma sycophanta* beetle, also known as the caterpillar hunter, can eat as many as 150 gypsy moth caterpillars. Early in this century, imported *Calosoma* beetles were released in New England. But their natural spread has lagged behind that of the gypsy moth. To test a different strategy, scientists in 1994 released about 100 caterpillar hunters at each of five plots in Delaware, Michigan and West Virginia. The beetles didn't go hungry: The species reproduces only if gypsy moth is on the menu, and they reproduced at each plot. Releasing beetles near leading edges of the moth's spread, for example, in Michigan, could efficiently get the predators established to start hunting down pesky caterpillars. Study collaborators were with ARS, Connecticut Agricultural Experiment Station, Michigan State University, West Virginia University and USDA's Animal and Plant Health Inspection Service. The West Virginia scientist is conducting new tests, and releasing *Calosoma* to help protect irreplaceable chinkapin oak trees—several hundred years old—at the university's arboretum. Meanwhile, a Connecticut researcher is devising an artificial diet for rearing large numbers of *Calosoma* beetles in the laboratory.

Beneficial Insects Introduction Research Laboratory,
Newark, DE
Roger W. Fuester, (302) 731-7330

Interplanting two or more oilseed crops in alternating strips produced yields similar to conventional one-crop systems. In field tests, ARS researchers strip-cropped canola and soybeans. The strip crops reduced the need for insecticides, helped control weeds without chemicals, used less fertilizer and produced more and better quality oil. Another plus: Seed oil and crude protein concentrations were higher in the strip-cropped system. Results indicate intercropping can be as economical and profitable as conventional systems.

Plant Science Research Unit, St. Paul, MN
Carroll Vance, (612) 625-5715

Weevils that devour stored grain could have their meal tickets revoked by a tiny wasp that is a natural enemy. The weevils are becoming resistant to the pesticide malathion, the conventional weapon used against them. But the wasps, *Anisopteromalus calandrae*, can survive malathion applications. ARS scientists found that this makes the wasps a promising tool in a two-punch strategy—malathion to kill weevils that haven't developed resistance plus wasps to wipe out the rest. Female wasps deposit eggs on weevil larvae, ensuring a future food source for new-born wasps. ARS researchers say the wasps' malathion resistance is the result of a single gene that could be transferred to other species of beneficial insects. That would give farmers an option in using integrated pest management (IPM) strategies to combat pests that develop resistance to malathion.

Biological Research, Manhattan, KS
James E. Baker, (913) 776-2785

A protein that helps destructive lygus bugs sniff out cotton plants—or prospective mates—could prove to be the pests' undoing. That's if ARS scientists can exploit the protein as a new alternative to chemical insecticides. One possibility: block the protein's production as the bug nears maturity. Then, the bug may be unable to heed important chemical cues—odors from tasty plants or the sex attractant emitted by a potential mate. Researchers isolated the "odorant binding protein" (OBP) from tiny hairs on the bug's antenna. This chemical-sensing organ serves as a nose and shuttles odor molecules to special nerve cells that alert the insect that food or other bugs are near. OBP's are found in humans and other animals. But they've been found in only three insects: the lygus bug and two species of moth. In the United States, the lygus bug is a costly pest of cotton, alfalfa, soybean and other crops. Its feeding robs plants of vital nutrients, causing them to wilt and die.

Insect Chemical Ecology Laboratory, Beltsville, MD
Joseph C. Dickens, (301) 504-5223

Soil, Water and Air Quality

Erosion-control efforts could benefit from microscopic hitchhikers that are helping scientists track down the source of dust particles that blow into cities. A new approach for analyzing dust-carried microorganisms was devised by ARS researchers. It's the first technique able to distinguish dust blown off dirt roads from dust that started as eroded soil from farms. In the technique, scientists analyze fatty acid profiles of different microbes in windblown dust. Fatty acids are chemicals that help

form a cell's structure. Each group of microbes has a unique profile—just as every person has a unique set of genes. Microbial communities that live in organic cropland soils, for example, differ from microorganisms that thrive in the compacted soil that makes up an unpaved road. First, the scientists establish profiles from microorganisms collected in pollution-monitoring air filters. They compare these with a library of profiles from soil samples across Washington state. Similarities between a filter sample and a library sample suggest the dust's area of origin. Farmers and air quality authorities can use the results to gauge success of erosion control practices. That's because, over time, reducing erosion will alter the makeup of the dust's microbial profiles. (PATENT APPLICATION 08/548,852)

Land Management and Water Conservation Research Unit, Pullman, WA

Ann Kennedy, (509) 335-1552

Encapsulating herbicides in cornstarch "packaging" delivers them to the right spot in the soil—reducing the chance they'll be lost in the air. When herbicides that are not encapsulated are sprayed on crop fields, they're exposed to wind, rain and warm temperatures that facilitate herbicide loss into the air as a vapor. These airborne herbicides can land in waterways at least 150 miles away. Scientists used mobile chambers to measure vapor losses for the first 35 days after atrazine and alachlor were applied to plowed and unplowed cornfields. Rain in the first week after application helped reduce overall herbicide loss in the atmosphere. But, in the unplowed fields, losses of alachlor wrapped in cornstarch capsules dropped from nine to four percent—meaning more herbicide stayed in the soil to fight weeds. Atrazine losses dropped from four to almost two percent when that chemical was spread in capsules on unplowed fields. Even the non-encapsulated pesticides had lower losses on unplowed fields, because plant stubble on the surface helped bury and shelter the herbicides from air and higher temperatures. On plowed fields, packaging the herbicides in corn starch did not lower the 14-percent alachlor vapor losses, but cut atrazine losses from four to almost two percent.

Hydrology Laboratory, Beltsville, MD
Timothy J. Gish, (301) 504-7490

Animal Diseases and Pests

Broiler chicks fed a diet of ground wheat can succumb to an intestinal bacterium that causes disease. But a tiny amount of pine shavings can reduce that risk, ARS and university studies suggest. This could be especially welcome news to southeastern poultry

producers. As a feed source, locally grown wheat helps cut the cost of shipping in corn from the Midwest. For the young birds, ground wheat is as nutritious as corn. Scientists found wood shavings supply fiber to help the wheat can pass through the chick's intestinal tract. Otherwise, it can collect there and stagnate. This promotes rampant growth of a natural bacterium called *Clostridium perfringens*. It causes necrotic enteritis—intestinal lesions that can impede the chicks' digestion or even kill them. In studies, the scientists started 14- and 21-day old chicks on diets of corn, ground wheat by itself, and wheat with pine shavings. They infected one group of birds on each diet with the bacteria. Chicks fed only wheat had many lesions. Those fed only corn had few or none, and the chicks fed wheat with a four percent concentration of pine shavings fared almost as well. The scientists plan further research before passing on their findings to poultry producers.

Poultry Research Unit, Mississippi State, MS
Scott L. Branton, (601) 323-2230

ARS scientists have found new clues for coping with two problems in the egg industry. The problems are egg contamination with *Salmonella* and low egg production by older hens. In one study, scientists found that a chicken's natural resistance to *Salmonella* infection plummets after it is put on a fast for a week or so. Fasting, a common industry practice, causes hens to molt. This triggers hormonal and other changes, restoring up to 90 percent of the hen's egg-laying capacity. In tests, fasted chickens became infected with *Salmonella* after ingesting as few as 10 bacterial cells. Typically, a chicken becomes infected after ingesting ten thousand or more *Salmonella* cells in fecal matter shed by an infected bird. But, the increased susceptibility of fasted hens also leaves them more vulnerable to contracting an infection by a less common route—through the air. Plus, the increased susceptibility raises the odds of egg contamination. On average, the odds are low—less than three eggs in ten thousand. But that could be lowered further with an effective alternative to fasting. One method with potential is an experimental low-calcium diet developed at the University of Georgia. Joint studies by the university and ARS found that birds molted with this diet were 100-fold less susceptible to infection.

Southeast Poultry Research Laboratory, Athens, GA
Peter Holt, (706) 546-3442

A new gene-based test can more quickly and accurately determine if U.S. cattle and sheep carry the virus that causes bluetongue. The new tool could help open an estimated \$125 million annual export market now closed to U.S. cattle producers. Countries that do not have bluetongue disease bar importation of U.S. cattle, embryos and sperm. The new test can spot the

virus in 10 hours. Older tests take two weeks and may require use of hazardous chemicals. The new test would reduce the cost of testing animals destined for export. It first extracts any of the virus' telltale genetic material—called ribonucleic acid (RNA)—that may be in animal blood samples. For easy detection by standard analytical tools, the test reproduces hundreds of copies of the viral RNA fragments.

*Arthropod-borne Animal Diseases Research
Laboratory, Laramie, WY
William C. Wilson, (307) 766-3600*

Raising armies of larkspur myrid bugs may help discourage cattle from munching on poisonous tall larkspurs. In western mountain ranges, more cattle die from eating tall larkspurs than from any other plant or disease. The deaths, control costs and related expenses cost ranchers about \$20 million a year. No antidote exists for the plant's toxic alkaloids. In a preliminary test, four cows preferred tall larkspurs undamaged by the myrid, a native species (*Hopplomachus affiguratus*). Adult myrids, about one-eighth-inch long, use beak-like mouthparts to pierce larkspur leaves and flowerheads, then suck the juices. Injured leaves mottle and wilt; flowerheads won't mature to form seed. Tall larkspurs are the myrid's only known target. The blooms sport a distinctive spur, like their ornamental cousins—garden delphiniums. Researchers want to explore the potential of releasing myrids that would either augment existing colonies or establish new ones. With more myrids around to damage more of the tall larkspurs on a range, cattle may seek different, healthier plants to eat.

*Poisonous Plant Research Laboratory, Logan, UT
Michael H. Ralphs, (801) 752-2941*

Ticks that transmit Lyme disease to humans may find it deadly to get a free ride on white-tailed deer.

That's because of a new deer feeder dubbed "the four-poster." The feeder gets its name from four pesticide-loaded rollers that rub tick-killing chemicals on a deer's head and neck as it sticks its head inside the device to feast on corn. Treated deer help eliminate ticks from wooded areas rather than leaving the pests behind to find another host. Because the deer don't eat the pesticide, this method is safe for use during the October-December hunting season when the majority of black-legged ticks feed on deer. Pesticides used in the rollers are experimental, but researchers say the "four-poster" is more effective than fencing deer out of tick-infested areas. Lyme disease is most prevalent in the Northeast, the upper Midwest and in California. (PATENT 5,367,983)

*U.S. Knippling-Bushland Livestock Insects Research
Laboratory, Kerrville, TX
J. Mathews Pound, (210) 792-0321*

Dairy producers should watch for high potassium levels in dry feed rations because ARS researchers have proven that high potassium—not calcium—cause milk fever in cows. This new finding will reduce the incidence of milk fever, which costs up to \$20 million in medications to treat affected cows each year. Based on a three-year study of the diets of 60 Jersey cows, the researchers concluded that calcium levels did not play a role in the development of milk fever, thus disproving a generally accepted belief in the milk industry.

*Metabolic Diseases and Immunology, Ames, IA
Jesse P. Goff, (515) 239-8343*

Animal Productivity

For a calf's growth rate and other traits, the genes it inherits from its mother are no more important than those from its father, ARS scientists found. That contrasts with what some beef breeders have long believed—that the genetic potential for traits like calf size depended more on the cow's genes than the bull's. That thinking was based on the belief that at conception, there is extra DNA from the calf's mother in the mitochondria of the egg. The mitochondrial DNA—separate from the chromosomal DNA that is passed on by both parents—has been shown to affect milk yield in dairy cattle. This assumption has led some beef cattle breeders to base their selection techniques on the cow's bloodline rather than using the standard method that evaluates genes from both parents. ARS researchers showed that the standard method is best. They studied maternal lineages and calf traits of 26 cow families over more than 13 generations in Line 1 purebred Herefords. They found that both parents' genes contributed equally to economically important traits like calves' weight at birth, weight gain from birth to weaning and weight gain from weaning to one year of age.

*Fort Keogh Livestock and Range Research
Laboratory, Miles City, MT
Michael D. MacNeil, (406) 232-4970*

Food Safety and Quality

Two commercial blueberry varieties produced in Florida hold up well under irradiation, a treatment that could replace methyl bromide, now used to rid the fruit of quarantine pests. Methyl bromide is a chemical fumigant that is scheduled to be banned in the United States in 2001. ARS scientists subjected Climax and Sharpblue blueberries to low-dose irradiation with only minor effects that should not affect consumer

acceptance. Blueberries shipped to some U.S. and export markets must be certified free of certain quarantine pests. Currently, methyl bromide is the only approved quarantine treatment for blueberries against the apple maggot, blueberry maggot and plum curculio.

*U.S. Horticultural Research Laboratory, Orlando, FL
William R. Miller/Roy E. McDonald, (407) 897-7309*

A newly discovered natural compound in tomatoes is important to the fruit's flavor, ARS researchers have learned. This information can be useful to tomato breeders and processors. The compound, furaneol (pronounced fur-ANN-ee-ohl), is the latest of 40 tomato compounds discovered by an ARS research team over the past several decades. The scientists rank furaneol as among the ten most important compounds for tomato flavor. Now, breeders can check new tomato types to make sure the fruit contains this compound. Plus, processors can monitor paste, salsa and other products and add back any furaneol lost in processing the tomatoes.

*Western Regional Research Center, Albany, CA
Ronald G. Buttery, (510) 559-5667*

Hawaiian growers now have a practical method for protecting the quality of Sharwil avocados that undergo a required, newly approved anti-fruit-fly treatment before being shipped to mainland markets. Any of four approved regimens of chilling—to freezing or near-freezing temperatures—will ensure that the avocados won't harbor live Mediterranean or oriental fruit flies or melon flies. To prevent these chill treatments from blackening the thin, bright green skins of the avocados—and making them unmarketable—ARS researchers recommend two simple steps: Before chilling, heat the avocados for eight to 12 hours in a room that's kept at 98.6 to 100.4 degrees F, then cool them for four hours at 68 to 73 degrees F. ARS tests with 8,000 Sharwils showed the process won't harm the fruit's rich, buttery taste and creamy texture. If live stowaway fruit flies were to reach the continental United States, they could thrive on many fruit and vegetable crops in warm-weather states such as California, Florida and Texas.

*Tropical Fruit and Vegetable Research Laboratory,
Hilo, HI
Harvey T. Chan, Jr., (808) 959-4343*

Government raisin inspectors could soon have a new, more reliable tool from ARS for evaluating fruit quality. Raisins are graded on visual characteristics like plumpness, color and wrinkle depth or by a mechanical sorter that separates heavy from light fruit. The new method uses near infrared, or NIR, a form of electromagnetic radiation like light and X-rays. This provides a

numeric measure of quality that should improve raisin grading. USDA's Agricultural Marketing Service is testing the system and may use it to evaluate about 400,000 tons of fruit annually. When an object is exposed to NIR—or any type of electromagnetic radiation—it absorbs some energy, and either reflects or lets the rest pass through. Light or other radiation that passes through or reflects from raisins produces a spectrum that can be measured. ARS invented the technology more than 30 years ago, but until now it hasn't been applied to raisins. An ARS scientist discovered that high-quality raisins produce a spectrum different from that of low-quality raisins. The difference compares well with visual evaluations. Once calibrated, the NIR device can simultaneously measure many characteristics including acidity and water and sugar content.

*Process Chemistry and Engineering Research Unit,
Albany, CA
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Human Nutrition

Reduced-calorie diets that provide nutritious, well-balanced meals might nevertheless weaken the body's immune system. That's the suggestion of ARS researchers who conducted a preliminary study of 10 women volunteers. The scientists wanted to pinpoint how dieting affects the immune system, since one-third of all Americans are overweight, and many choose to cut calories to shed pounds. Most of what is known about the interaction between dieting and the immune system is based not on moderate dieting but on extreme cases such as anorexia nervosa or acute starvation. In the experiment, scientists cut the volunteers' calories by about half—a moderate amount. That meant volunteers ate about 1,300 calories a day for 12 weeks. Women in the study were 28 to 46 years old and 45 to 75 pounds overweight. Scientists monitored two dozen standard indicators of the women's immune systems before, during and after the reduced-calorie stint. All the women remained healthy during the study. But scientists noted a 30 to 35 percent drop in the number of natural killer cells—part of the body's defense against tumors and viral infection—in the blood. And three serum immune system proteins (IgG, IgA and C3) decreased 10 to 15 percent. More needs to be learned about these changes. But researchers say the findings underscore the importance of medical supervision for any weight loss program.

*Western Human Nutrition Research Center, San Francisco, CA
Darshan S. Kelley, (415) 556-4381*

More evidence of a B vitamin's importance for a healthy heart emerged from an ARS study. Researchers found that skimping on the vitamin, folate, may raise blood levels of an amino acid, homocysteine, in about a month. High homocysteine levels have been linked to low folate and blamed for increased risk of heart attack or stroke. Ten men, age 33 to 46, volunteered for the 108-day study by researchers with ARS and the University of California at Los Angeles. At various times, volunteers received 12, 84 or 220 percent of the Recommended Dietary Allowance (RDA) of folate. The current RDA for men is 200 micrograms. The low-folate stints made the test unique. Four volunteers in the study showed moderately elevated homocysteine after only 30 to 45 days of the lowest-folate intake. Their homocysteine levels quickly dropped to normal with the 220 percent RDA intake. Raising the RDA would increase the margin of safety, the researchers suggest. Folate is essential for growth and health of cells and proper functioning of the brain and hormones. The many good dietary sources include liver, leafy green vegetables, lentils and other dry legumes, orange juice and fortified breakfast cereals.

Western Human Nutrition Research Center, San Francisco, CA

Robert A. Jacob, (415) 556-3531

Today's method for checking the body's supply of vitamin A might be replaced within a few years by a simple, fast and easy blood test that ARS researchers are now developing. When ready, the blood test would make the current technique—a liver biopsy—unnecessary. Researchers have newly paired two laboratory techniques—supercritical fluid extraction and reversed phase liquid chromatography—to more accurately measure vitamin A supplies in liver samples. Their analyses should quicken their search for a compound in blood that would give an equally accurate reading. Liver biopsies, though painful, are currently used for vitamin A tests because that is where the body keeps its largest reserves of this vitamin. The blood test that the researchers envision could be used by physicians and other healthcare professionals to check their patients' vitamin A stores. And it might be used in the national health and nutrition surveys, co-sponsored by USDA, that are a key source of new information for evaluating and fine-tuning the nation's Recommended Dietary Allowances—or RDAs—for essential nutrients such as vitamin A. According to current USDA estimates, about 55 percent of all Americans receive less than the RDA for vitamin A.

Western Human Nutrition Research Center, San Francisco, CA

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Industrial (Non-Food) Products

When the heat's on, permanent-press cotton may reveal how it got that way. Some permanent-press treatments are formaldehyde-based, while others rely on non-formaldehyde agents such as polycarboxylic acids. A piece of equipment called a "thermal gravimetric analyzer" helps tell the difference. ARS researchers have adapted this standard piece of research equipment to find out what kinds of permanent press treatments were used on a fabric. Garment companies could use this analysis to decide whether the cloth they buy meets their requirements. Another potential use: testing international shipments of cotton fabric. The analyzer gradually heats bits of cotton fabric at rising temperatures. The cotton cellulose then chars away. But the agents used to make the cotton fabric dry smoothly have different characteristics, such as melting points that can be charted by time and temperature. In the case of formaldehyde-based finishes, researchers say it's even possible to estimate finish concentration and whether certain additives were used in the treatment solution.

Southern Regional Research Center, New Orleans, LA
Brenda J. Trask-Morrell, (504) 286-4532

Bacteria that ferment agricultural byproducts produce compounds that could replace alginates, used as thickeners and gelling agents by food and nonfood industries. Commercial alginates come from seaweed, but their composition varies depending on what type of seaweed, as well as where and when the seaweed was harvested. ARS researchers have shown that several plant-associated bacteria, harmless to humans and animals, produce alginates with stable compositions. These bacteria can be commercially produced via fermentation.

Eastern Regional Research Center, Philadelphia, PA
William Fett, (215) 233-6418

New forms of commercially available gellan gum could play a part in a wide range of products from drug encapsulating agents to controlled-release fertilizers. Gellan gum's usefulness has been limited because it wouldn't dissolve in water at room temperature. It's been used mostly as a gelling agent for plant and cell tissue culture media, replacing traditional agar. A new procedure from ARS scientists solves the problem by removing impurities in the gum. The new water-soluble gums could be used to encapsulate heat-sensitive materials such as enzymes and cells. The same process that takes out impurities also eliminates most of the

gum's contaminating phosphorus, which had hampered some scientific studies with plant roots and mycorrhizal fungi.

*Eastern Regional Research Center, Philadelphia, PA
Landis W. Doner, (215) 233-6422*

Bubbling nitrogen and changing clay composition have more than doubled potential production of mono-estolides, industrial compounds made from meadowfoam and other vegetable oils. These compounds could be used in biodegradable lubricants, cosmetics and detergents. In 1991, ARS researchers patented the process for making monoestolides from vegetable oils' fatty acids. At that time, the maximum yield of monoestolides equalled only 15 percent of the volume of the starting ingredients. Recent studies found that changing the clay's surface made it a better catalyst, and injecting bubbles of nitrogen boosted yields to 35 percent.

*New Crops Research, Peoria, IL
Selim M. Erhan, (309) 681-6213*

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Quarterly Report

of Selected Research Projects

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AG Libran

Into the Marketplace

Natural extracts from seed of the neem tree are the key ingredient in three new commercial products registered by the Environmental Protection Agency for pest and disease control. ARS scientists pioneered the use of neem seed as an alternative for chemicals. One of the findings was that neem extracts can control pests such as whiteflies, aphids, mealybugs and mites. Another finding was that neem can protect several ornamental and food crops against fungus diseases such as rusts and powdery mildew that attack leaves. All three products—the first to control insects and fungi at the same time—were developed under a cooperative research and development agreement between ARS and the W.R. Grace and Company of Columbia, MD. The products, called Trilogy, Triact and Rose Defense,

Contact the scientists who are listed for further information on each research project. For general questions about this report, contact Sean Adams or Lisa Spurlock, ARS Information, 6303 Ivy Lane, 4th Floor, Greenbelt, MD 20770, (301) 344-2723/2824, sadams@asrr.arsusda.gov or lspurloc@asrr.arsusda.gov

Items marked with the word PATENT are being patented by ARS. For more information on patents, CRADAs and patent licenses, contact C. Andrew Watkins, National Patent Program, Bldg. 005, Rm. 416, BARC-West, Beltsville, MD 20705, (301) 504-5734. Questions about a company's product and/or research should be directed to the company itself.

This publication is available on the ARS Home Page at <http://www.ars.usda.gov/is/>

depending on the marketing niche, are covered by five U.S. patents held jointly by the USDA and Grace. (PATENT 5,298,251; 5,356,628; 5,372,817; 5,405,612; and 5,409,708)

*U.S. National Arboretum, Washington, DC
James Locke, (301) 504-6413*

Cooperative Research and Development Agreements

...With Ecogen, Inc., Langhorne, MA, and Mantrose-Haueser, Attleboro, MA, to produce coatings containing an ARS-patented natural yeast that protects grapefruit from postharvest diseases. These new coatings can extend the shelf life of grapefruit for up to two months. Unnoticeable on treated fruit, the coating can be applied at the packinghouse to prevent green mold, which feeds on nutrients on the fruit's surface. The protective yeast thrives on the same nutrients, so it crowds out the fruit-damaging mold, making it an ideal candidate for a biocontrol product.

ARS Contact: Raymond G. McGuire, Subtropical Horticulture Research Station, Miami, FL, (305) 238-9321

...With Intertec of Lynchburg, VA, to merge an ARS-patented tensiometer valve with a pulse irrigation system patented by the company to increase irrigation efficiency. As the soil dries, increasing suction causes the tensiometer valve to open, delivering water as needed. When the soil has received enough water, the suction decreases and the valve closes without the need for electricity and wires. The tensiometer valve will reduce water consumption and leaching of nutrients below the root zone, while maintaining high productivity. This system can be used in fruit and vegetable production, landscape applications, nurseries and in home gardens. (PATENT 5,156,179)

ARS Contact: D. Michael Glenn/D.L. Peterson, Appalachian Fruit Research Station, Kearneysville, WV, (304) 725-3451

...With Florida's Department of Citrus, Lakeland, FL, to adapt a spiked-drum shaker to pick oranges. An ARS engineer previously invented and received a patent on a new shaker that mechanically harvests berries and other fruits, thereby improving the quality of harvested fruit and reducing growers' picking costs. BEI, Inc., South Haven, MI, is licensed to manufacture the spiked-drum shaker and is using it in a harvester for

fresh market quality blueberries. Now the Florida citrus industry hopes to use the same technology to mechanically harvest oranges for the processing market. (PATENT 4,860,529)

ARS Contact: Donald Peterson, Appalachian Fruit Research Station, Kearneysville, WV, (304) 725-3451

...With Automata, Inc., of Grass Valley, CA, to develop equipment to automatically control water flow in irrigation canals, insuring timely delivery of water that satisfies crop demands. ARS scientists and cooperators created the basic technology, including software, that could be used on large and smaller secondary canals. Automata, Inc., will assist in developing low-cost electronic controls for water flow gates. A major goal is balance the many complex variables involved in providing a constant flow of irrigation water through hundreds of miles of non-standardized canals.

ARS Contact: Albert J. Clemmens, U.S. Water Conservation Laboratory, Phoenix, AZ, (602) 379-4356

...With Union Camp of Savannah, GA, to improve methods for cloning trees that will quickly yield high amounts of biomass for pulp and paper. ARS researchers hope to learn whether the goal can be achieved by nurturing tissue cultures with excess carbon dioxide generated during corn to ethanol production. Cutting the time required to produce a crop could greatly reduce forest industry costs. ARS scientists' task: create a combination of automated systems for shortening the time in starting up loblolly pine and sweetgum clones in tissue culture. Thousands of sweetgum clones can be cultured in a laboratory at one time and then transplanted outdoors. Union Camp will determine how these clones perform after they are planted in the field.

ARS Contact: Brent H. Tisserat, National Center for Agricultural Utilization Research, Peoria, IL, (309) 681-6289

...With Bioplastics, Inc., a subsidiary of MBI International in Lansing, MI, to further develop and commercialize biodegradable sheets of film for packaging. Bioplastics has a grant from USDA's Small Business Innovation program to develop the films. ARS scientists developed the films from a combination of starch, glycerol from either animal fat or corn, and pectin, a major component of fruits and vegetables. They could be used as packaging that dissolves in cooking, such as a film wrap for soups, or to separate food on packaging trays. A patent has been granted for the films, which also have potential for biodegradable, water-soluble industrial uses such as in flushable diapers and other hygienic products. (PATENT 5,451,673)

*Eastern Regional Research Center, Wyndmoor, PA
Marshall L. Fishman, (215) 233-6450*

...With EPL Technologies, Inc., Conshohocken, PA, to commercialize a new process that keeps pre-peeled potatoes from turning brown for up to two weeks without using sulfite. Pre-peeled potatoes, widely used by food processors and the food service industry, rapidly brown if not treated with browning inhibitors. Sulfite, the most effective anti-browning compound for potato products, leaves a residue in food that can trigger an allergic reaction in some consumers. Under the new ARS-EPL process, scientists treat pre-peeled potatoes in a heated solution containing FDA-approved food additives, and then apply a different sulfite substitute without heating. The combined treatments maintain quality and shelf life of the product for two weeks without adversely affecting product texture. Current sulfite substitutes forestall potato browning for only one week and often induce textural defects.

*Eastern Regional Research Center, Wyndmoor, PA
Gerald M. Sapers, (215) 233-6417*

...With Consep, Inc. of Bend, OR, to develop a spray that would immediately repel attacking bees, including highly defensive Africanized honey bees. Small canisters of a safe, nontoxic, pleasant smelling bee repellant could be handy protection for letter carriers, meter readers, utility and construction workers, campers and others. The bee spray being investigated by ARS scientists has as its major ingredient a mimic of a natural repellant that queen bees produce to keep worker bees out of their way. Africanized bees invaded the United States a few years ago via Mexico. They now are found in Arizona, California, New Mexico and Texas.

ARS Contact: Eric H. Erickson, Carl Hayden Bee Research Center, Tucson, AZ, (520) 670-6380

...With GFK Consulting Ltd., of San Clemente, CA, to design and test a safe, fast, affordable system to trap methyl bromide after its use in fumigating harvested crops. The system might offer packers of strawberries, cherries, oranges, peaches and other crops an effective way to reduce emissions of methyl bromide vented into the atmosphere from fumigation chambers. Methyl bromide is commonly used so that American packers can ship high-value, insect-and-disease-free produce that meets the strict quarantine standards of importing nations. But, because commercially used methyl bromide is implicated in damaging Earth's protective ozone layer, it is scheduled to be phased out by 2001. Reducing the emissions, however, might lead to a new okay for use of methyl bromide for fumigating commodities. So, researchers are testing several different activated-carbon filters to determine what works best at various temperatures, humidities and methyl bromide concentrations. Chemical companies would recycle the spent carbon.

This would break down trapped methyl bromide into water, carbon dioxide and sodium bromide. The latter could be used to manufacture methyl bromide or other bromine chemicals. The idea of employing carbon filters to trap methyl bromide isn't new. Today's packinghouses nevertheless lack the kind of thoroughly tested recycling system planned by the researchers.

ARS Contact: James G. Leesch, Horticultural Crops Research Laboratory, Fresno, CA, (209) 453-3090

A Memorandum of Understanding has been signed with Kalium Canada, Ltd., of Regina, Saskatchewan, to investigate substituting potassium chloride for common salt now used by the meat packing and tanning industries to preserve raw animal hides. With this new process, these industries can eliminate an environmental problem: the disposal of used salt brine. Unlike sodium, potassium is a plant nutrient, so waste from the new process can be recycled into fertilizer. ARS scientists are working with the affected industries to demonstrate this process, which they have shown does not affect the quality of the leather. Kalium Canada, Ltd. is a subsidiary of the American company Vigro.

*Eastern Regional Research Center, Wyndmoor, PA
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Human Nutrition

Iron levels did not increase in postmenopausal women when they ate several servings of meat and poultry daily for seven weeks. That's good news because epidemiological studies have associated excess iron in the body with increased risk of cardiovascular disease. It is thought that having too much iron—as measured by serum ferritin—raises the chance that free iron ions will be available to damage blood vessels and other tissues. Results of this study indicated that eating meat had little effect on iron stores after seven weeks. Young women regularly lose iron through the menstrual flow. But women past menopause and men tend to accumulate the mineral unless they regularly donate blood. During the five-month study, the 14 women consumed three different diets: high-meat, low-meat and low-meat with mineral supplements to supply missing nutrients. The extra protein in the high-meat diet did not reduce the women's calcium status, as suggested by some research. They did not excrete more calcium or experience a drop in body calcium levels or bone metabolism, which corroborates other findings and indicates that calcium status cannot be used as a rationale for eating less meat. Lastly, the high-meat diet improved the women's zinc absorption. They absorbed more zinc from the high-meat diet than they did from the low-meat diet, even when it was supplemented with zinc.

Grand Forks Human Nutrition Research Center,

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Evidence is growing that vitamin K—well known for its role in blood clotting—is also crucial for healthy bones. Researchers at ARS' center on aging improved chemical methods for measuring the vitamin K content of different types of foods. They then expanded their database of vitamin K levels by analyzing more than 250 foods collected nationwide by the Food and Drug Administration for its Total Diet Study. Using these data, the ARS researchers estimated the vitamin K intake by 14 age and gender groups, based on the FDA model of typical consumption. With the exception of 25 to 30-year-old men and women, most Americans get the vitamin K daily Recommended Dietary Allowance of about 85 micrograms—that's millionths of a gram. The richest sources of vitamin K are green, leafy vegetables. One serving of spinach or collards, for instance, or two servings of broccoli provide four to five times the RDA. The greener the vegetable, the higher the content, say the researchers, because the vitamin is associated with the chlorophyll. Vegetable oils—soybean, canola and olive—and dressings containing them are the second best source. Animal foods are poor sources unless they are cooked, processed or packaged with one of these oils—but not corn or peanut oil, which are much lower in vitamin K.

*Jean Mayer USDA Human Nutrition Research Center
on Aging at Tufts, Boston, MA*

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Preliminary evidence suggests that people may need more vitamin K than the current Recommended Dietary Allowance to maintain strong, healthy bones. The vitamin activates at least three proteins involved in bone formation. One of them, osteocalcin, needs to be saturated with chemical structures known as carboxyl groups. And the attachment of these carboxyl groups requires vitamin K. Earlier this year, French scientists found that older women with elevated blood levels of the undersaturated protein had lower bone density and a higher risk of hip fracture. So ARS researchers conducted a pilot study, using their newly developed blood test, to see if extra vitamin K could increase saturation, thereby improving the outlook for bone health. It did. When nine healthy, young men and women consumed four times the RDA for vitamin K, their levels of the undersaturated protein were significantly lower than when they consumed the RDA. They also excreted less of the carboxyl groups, indicating that more were being added to protein. The vitamin is well known for its role in blood clotting, and the current RDA—around 85 to 95 micrograms (mcg) per day—is based on the requirement for normal clotting. People can increase their vitamin K

intake by adding one or two servings of spinach, kale, collard greens or broccoli to their daily diet—provided they get some fat at the same meal so the vitamin will be absorbed.

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Stomach acid apparently plays an important role in the absorption of beta carotene and other carotenoids recognized for their antioxidant activity in the body. That is according to the results of a recent test. A group of 12 men and women took a drug, omeprazole, for nine days to temporarily block the production of stomach acid. Then they took a 120-milligram beta carotene supplement. Their blood levels of beta carotene rose only half as much, compared to their beta carotene levels when they took the supplement without taking the drug. This helps explain why—in a nutritional status survey of elderly conducted in the early 1980's by this ARS center—the lowest levels of carotenoids were seen in participants who had lost the ability to secrete stomach acid. About 30 percent of people over age 60 have this condition, known as atrophic gastritis or hypochlorhydria. The researchers suspect that long-term infection with *Helicobacter pylori*, the bacteria that causes stomach ulcers, contributes to the destruction of acid-secreting cells. They theorize that eating more sour foods may increase carotenoid absorption, but have not yet done such tests. Normally, stomach acidity is around a pH of 1. The omeprazole drug raised the study volunteers' stomach pH to between 4.6 and 7.4.

Jean Mayer USDA Human Nutrition Research Center on Aging at Tufts, Boston, MA

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Skeletons made of epoxy resin are helping researchers at the Children's Nutrition Research Center in Houston improve the accuracy of bone mineral content measurements in growing children. Using a dual-energy x-ray absorptiometer, or DXA, is becoming a common tool for measuring bone, fat and lean mass in people because of its precision and ease of use. But others using the DXA have reported a loss of bone mineral content in volunteers who have lost weight. The Houston researchers wondered if this was an actual loss or if the DXA was "seeing" more bone mineral when the subjects had more fat in their bodies. So they filled the skeletons with predetermined amounts of calcium to approximate the content in children and adolescents at ages 4, 10, 15 and 18. With each section of the skeleton

encased in plastic cylinders, these "phantoms" resemble distant cousins of the Tin Man in *The Wizard of Oz*. But they answered the question. Their calcium content, as measured by the DXA, agreed closely with the actual amount of calcium added. When they were made 15 to 20 percent heavier, however, by laying strips of a fat simulating material over the abdomen, hips and thighs, the DXA measured a small but significant increase in calcium content—about 2.5 percent more. The correction will enable researchers to more accurately gauge the true rate of bone growth in children. And they plan to use the epoxy phantoms to calibrate other equipment for measuring minerals in the human body, such as the whole body counter and neutron activator.

Children's Nutrition Research Center, Houston, TX
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Premature infants who receive small amounts of breast milk or formula within days of birth—in addition to intravenous feedings—may get a much needed boost in intestinal development. This may enable them to more quickly tolerate regular feedings, a prerequisite for release from the hospital. Preliminary findings, based on the progress of 70 premature infants weighing less than 2.5 pounds at birth, indicate that early feedings stimulate production of lactase. That's the enzyme that digests the major milk sugar, lactose. For years, very low birth weight infants have received intravenous (IV) feedings exclusively for the first two weeks. Because these infants didn't produce the enzyme, doctors thought the undigested sugar from breast milk or formula would increase the risk of necrotizing enterocolitis—a serious complication that destroys the intestinal lining. But this ongoing study strongly suggests that the advantages of early feedings outweigh the disadvantages. Half the infants were introduced to less than one-quarter cup of breast milk or formula each day beginning only four days after birth. The other half received only IV feedings for two weeks. A test administered three times during their first month showed that the early feeding group had significantly higher lactase activity for the first three weeks.

Children's Nutrition Research Center, Houston, TX
Robert Shulman, (713) 798-7145

Oatrim retains its health benefits equally through baking or boiling. That's based on a test of its ability to reduce blood glucose, thereby reducing the risk of middle-age diabetes. Twenty-four men and women had as much improvement in their glucose tolerance after consuming baked or boiled pudding containing Oatrim as they did with instant pudding. The ARS-developed fat replacer contains beta glucans, a fiber component that lowers cholesterol, and is now found in many processed foods. In an earlier long-term study, Oatrim

significantly reduced volunteers' cholesterol, blood pressure, glucose and the hormones controlling glucose tolerance. And they lost weight, despite efforts to prevent weight loss. The researchers wanted to know if the cooking method altered Oatrim's efficacy. Judging from the glucose responses of these volunteers, it made little difference. Total dietary fiber was slightly higher in uncooked Oatrim, and it produced a bigger response in one of the hormones that control blood glucose. But there was no difference between the cooked puddings. Oatrim can't be fried.

*Beltsville Human Nutrition Research Center,
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It's now possible to take in 5,600 foods at one sitting without gaining a pound. Just download the new USDA Nutrient Database for Standard Reference (SR11) from the Internet or the laboratory's bulletin board. It's free of charge. This eleventh release of the food composition tables lists values for more than 70 food components—such as vitamins, minerals, lipids, amino acids, fiber and energy (calories)—in over 5,600 foods grouped into 22 categories. It replaces SR10, issued three years ago, as well as the printed publication—USDA Handbook No. 8. The nutrient database is a major source of food composition data for epidemiological researchers as well as food and nutrition professionals, and serves as the foundation for most commercial nutrient database programs. In the latest version, laboratory nutritionists have added new food items, such as ethnic foods, brand name candies and infant formulas and foods. There are also updated values for breakfast cereals, new sodium values for canned vegetables and soups, and new data for beef and lamb cuts with external fat trimmed to 1/8 inch, reflecting recent market changes. SR11 is more user friendly than older versions because of its new, relational format. Users with relational database management software—such as Paradox, Access, or Dbase—can retrieve information and generate their own reports. On the Internet, SR11 can be retrieved from the Nutrient Data Laboratory Home Page: <http://www.nal.usda.gov/fnic/foodcomp>. Staffers have also added a search tool for locating the nutrient values of selected foods. Those without an Internet connection can retrieve the database from the Nutrient Data Laboratory Bulletin Board by dialing (301) 734-5078. This version does not have a search tool, however. A CD-ROM of the database will be available sometime next year.

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Evidence that the vitamin folate—known as folic acid on supplement labels—may reduce the risk of colorectal cancer got another boost in a recent study of rats. As the amount of folate in their diet increased, the number of rats that developed tumors of the colon and rectum from high doses of a known carcinogen decreased proportionately. So did the number of tumors per rat. In the human diet, green vegetables, organ meats and citrus are rich sources of folate. Colorectal cancer is the second leading cause of cancer deaths in the United States, claiming 60,000 lives annually. Each year, 150,000 new cases are diagnosed, and up to 90 percent are thought to be related to diet. Epidemiological studies by others repeatedly have found more precancerous growths—or adenomatous polyps—in the colons of people with low folate intakes or blood levels. They also found the converse: Fewer polyps in the colons of people with high folate intakes or blood levels. Looking for a cause-and-effect link, ARS researchers turned to a rat model in which the colon cells go through precancerous changes similar to those of humans. One group of rats was given the recommended folate level for rats in their feed. A second group got four times the recommended level, and a third group got 20 times the recommended level, while the control group got no folate. About 70 percent of the control rats developed tumors after being challenged with high doses of the carcinogen dimethylhydrazine. That dropped to 40 percent of the group given the recommended folate level and to only 10 percent of the group given four times the recommended level. Excessive amounts of folate, however, did not increase protection. In fact, the group getting 20 times the recommended level tended to have more tumors than the rats getting four times the requirement. The same pattern occurred for the number of tumors per rat. The findings extend those of an earlier study in which extra folate protected the colorectal cells of this breed of rats against precancerous changes after challenge with a much lower dose of the same carcinogen.

*Jean Mayer USDA Human Nutrition Research Center
on Aging at Tufts, Boston, MA*

*Joel B. Mason, (617) 556-3194,
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Getting enough dietary folate can reduce the risk of heart disease and stroke, even in those who have a glitch in their genes for converting the amino acid homocysteine to a less toxic relative. Folate—also known as folic acid or folacin—activates one of the enzymes that promote this conversion. This helps to prevent a backup of homocysteine in the cells, which gets dumped into the blood stream. Studies indicate that elevated blood levels of homocysteine increase the risk of cardiovascular disease, apparently by promoting artery narrowing. In 1988, a group of Canadian researchers

discovered a mutation on the gene that acts as a blueprint for this enzyme. That mutation produces a less efficient enzyme. ARS researchers, in collaboration with one of the Canadian researchers, wanted to know if the enzyme's activity depends on the level of folate in the blood. So they tested blood samples from 365 people enrolled in the National Heart, Lung and Blood Institute's Family Heart Study and found that it did—but only in the subjects who had two copies of the genetic variant, one on each chromosome. Twelve percent of the volunteers had this double variant. Among this group, those whose blood folate levels were below the study median—6.8 nanograms per milliliter—had significantly higher homocysteine levels than the volunteers with only one or no copy of the variant. But those whose folate levels were above the median had normal homocysteine levels. This genetic variant is quite common, the study found. Forty-seven percent of the volunteers had at least one copy, while 41 percent had none. It's easy to get enough folate through the diet. Green vegetables and citrus are rich sources.

Jean Mayer USDA Human Nutrition Research Center on Aging at Tufts, Boston, MA

Paul F. Jacques, (617) 556-3322, paul@hnrc.tufts.edu

Middle-aged women in the military who fail to meet the body fat standard based on tape measurements now have some data to question their score. In a study of women between the ages of 40 and 60, the tape measure method overestimated body fat by nine to 14 percent in some women and underestimated it by seven to 11 percent in others—compared to body fat measurements obtained by the long-accepted standard of underwater weighing. That's because the equations each branch of the military uses to estimate body fat from circumference measurements of arms, legs and abdomen were developed from studies of younger people. The researchers wanted to know if the equations accurately reflect body fat in older personnel, because service men and women who do not meet the standards must undergo a weight control program until they lose the excess fat. Failing that can be grounds for discharge. The cutoffs for body fat range from 26 percent for all women in the Marine Corps, to 36 percent for women over age 40 in the Army. Based on these standards, the Army equation overestimated body fat in the fewest number of women tested—one out of 52, or two percent of the group. The Navy equation overestimated body fat most often—in seven of 35 women tested, or 20 percent. Most of those who met the standards based on tape measurements also met them in underwater weighing. The findings point to the need for a larger study to assess and possibly revise these equations for personnel over age 40. The researchers chose to study older women first because this group is most under-represented in the current equations. But they suspect the equations may also need revision for older men.

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Body builders will find no help in a bottle of chromium supplements, contrary to claims that it boosts strength and muscle mass while reducing fat. A new, well-controlled study of 36 sedentary young men who volunteered for a weight training program found what other studies have been reporting: Those who took an extra 200 micrograms (mcg) of chromium daily gained no more strength or muscle bulk than those who got a placebo. And none of the men had a significant change in body fat, even after two months of working out five days per week. One third of the men took chromium picolinate. Another third took chromium chloride—an inorganic form of the mineral—for comparison, while the rest got a look-alike placebo. Their overall strength increased from 28 to 36 percent, on average, depending on the group. Their scores, however, were not statistically different from one another because of the wide range of body types in each group. The researchers concluded that the benefits of chromium supplements on body composition occur only in people with low intakes. Most Americans consume less than 50 mcg each day—the bottom of the range thought to be adequate—and may be operating on marginal levels. Because the chromium content of foods varies, sometimes dramatically, one insurance against deficiency is to eat a wide variety of foods and choose fortified cereals and whole grain breads over the more refined products. The study also found that the men taking chromium picolinate, but not chromium chloride, showed early signs of iron deficiency in three different assays of iron status. This suggests that extended use may be detrimental, especially in women before menopause, and needs further study.

Grand Forks Human Nutrition Research Center, Grand Forks, ND

Henry C. Lukaski, (701) 795-8353

Food Safety and Quality

Pistachio packers could save time and money in selecting only the highest-quality pistachios for consumers, thanks to an ARS-designed improvement in machine sorting. Hand laborers on a processing line can correct errors in machine-sorting, but this takes time and cuts into profits. The new ARS technique more accurately distinguishes pistachios with clean, light-colored shells from their dark-stained

counterparts. Stains can signal insect damage or, rarely, infection by *Aspergillus flavus*, a mold that produces aflatoxin. The ARS technique augments a bi-chromatic sorter—a device popular in packinghouses today—with a new machine-vision system. The system relies on digital scan cameras outfitted with microprocessors called DSPs—digital signal processors. Machine-vision systems that use DSPs are relatively new: the ARS work is the first application of the technology to pistachio sorting. New ARS software instructs the DSPs how to analyze images of pistachios whizzing past cameras at a rate of 144,000 an hour. Other customized ARS software tells a computer how to decide whether any of them has an unacceptable stain on the shell. In tests with more than 2,000 pounds of pistachios, ARS' prototype proved 90 percent accurate in its decisions, compared to 60 percent for the bi-chromatic sorter. (PATENT APPLICATION 08/550,310)

Western Regional Research Center, Albany, CA
Thomas C. Pearson, (510) 559-5868

Z-Trim, a new no-calorie, high-fiber fat replacer, could soon find a place in foods ranging from cheese products and hamburger to baked goods. An ARS scientist developed Z-Trim, which is made from low-cost agricultural byproducts such as hulls of oats, soybeans, peas and rice, or bran from corn or wheat. The hulls or bran are processed into microscopic fragments and purified, then dried and milled into an easy-flowing powder. When the powder absorbs water, it swells to form a gel that provides foods with an enjoyable smooth texture. (PATENT APPLICATION 08/563,834)

National Center for Agricultural Utilization
Research, Peoria, IL
George E. Inglett, (309) 681-6363

Udon noodles, a mainstay in Japan and attracting an ethnic market in this country, are being made with new, soft white wheat varieties developed by ARS scientists. The new varieties offer enhanced disease resistance that enables growers to use less fungicides. Udon noodles are popular in the United States with Japanese-Americans, as well as other consumers interested in ethnic, low-fat foods. Another market for the new varieties is in making wheat beer. Over 100,000 bushels of one of the varieties, Madsen, are used annually by one brewery to make wheat beer. Udon noodles are a thicker version of spaghetti with a similar taste.

Wheat Genetics, Quality, Physiology and Disease
Research Unit, Pullman, WA
Kay Simmons, (509) 335-8696

Genetic Resources

You can't judge a book—or, it seems, a fungus, mold or yeast—by its cover. That's what ARS scientists are finding as they use DNA "fingerprinting" to sort more than 80,000 yeasts, fungi and molds in the world's largest public-accessible collection of such organisms, based at Peoria, IL. DNA fingerprinting uses the unique aspects of each organism's genetic makeup as a means of identification. Previously, scientists classified organisms based on their size, shape or ability to thrive on a specific nutrient-laden medium. Researchers say this new identification system could help them identify disease-causing microbes and others that can be put to work as biocontrols against crop pests, weeds, and diseases. The genetic information also may provide important clues to an organism's geographic origins.

Microbial Properties Unit, Peoria, IL
Cletus Kurtzman, (309) 681-6561

Better breads and other baked goods for tomorrow may result from ARS scientists' success with gene-engineering wheat kernels. The scientists are the first to boost the amount of breadmaking proteins—known as high molecular weight glutenins—in wheat kernels. Breadmakers already know that flour high in these proteins yields light, fine textured loaves. Researchers increased the amount of the proteins as much as 50 percent in bioengineered wheat grown in the greenhouse. So far, six successive generations of the plants retained this trait. Sometime next year, the scientists expect to have enough flour from experimental plants to bake test loaves. One tool they used in the work is a genetic on-and-off switch called a promoter. It might work equally well to ratchet up—or down—other key proteins in wheat kernels. This, in turn, might lead to additional gene-engineering of wheat to yield an array of unique new flours or innovative by-products for industrial uses. (PATENT APPLICATION 08/586,331)

Western Regional Research Center, Albany, CA
Ann E. Blechl, (510) 559-5716

Imagine taking a trip and creating the roadmap as you travel. That's what researchers are doing as they draw the genetic map of the domestic chicken. The scientists are identifying "markers" along strands of genetic material called DNA, which makes up the genetic "highway" of the chicken. They use these markers to locate sites on the DNA strand where genes may be present that control economically important traits, such as meatiness, egg production or disease resistance. If researchers can pinpoint these genes, breeders could someday use this information to select for birds to meet market demands. At the heart of the work is information gleaned from the DNA of 52 crossbred

chicks whose parents were a domestic egg-laying chicken and a wild-type relative. ARS scientists are also using information from the human genome mapping project to approximate the location of particular chicken genes. By using what is known about where certain human genes are located, scientists can get a better idea of where to look for important genes in the chicken.

Avian Disease and Oncology Laboratory, East Lansing, MI

Hans Cheng, (517) 337-6758

Tomorrow's oats could also carry genes from corn. Researchers have successfully crossed oats, *Avena sativa*, with corn, *Zea mays*, in a quest to achieve better disease resistance in oats. Corn has qualities that would come in handy in oats, like resistance to crown rust, an airborne fungus that causes millions of dollars of oat crop losses each year in the Midwest. The fungus has overcome previously disease-resistant oat varieties. The cross-breeding of the two distinct species is part of an ongoing research effort to identify and achieve better disease resistance. No commercial varieties of oat-corn hybrids are being produced. Scientists hope using corn as a new source of resistance will fend off the fungus more effectively. Other advantages corn might lend to oats: increased heat tolerance, improved grain composition, and increased productivity.

Plant Science Research Unit, St. Paul, MN

Howard R. Rines, (612) 625-5220

Breeders are creating new soft red winter wheat varieties that will be more flood and drought tolerant. They are trying to incorporate a genetic trait already present in some commercial U.S. soft red winter wheats. These varieties had higher yields in Georgia soils despite a subsurface clay layer that normally restricts roots and causes wintertime waterlogging of soils. Flooding triggers these plants to form aerenchyma—large air channels that connect waterlogged roots to air spaces in plant stems. The channels allow the roots to “breathe”—meaning they have access to air and can survive underwater. What's more, the roots can penetrate the softened clay layer, which allows them to reach deep soil moisture during surface droughts. The rooting tolerance to soil waterlogging caused one of these varieties, Coker 9835, to have an average yield of 68.6 bushels per acre, compared to 49.85 for Bales, which has no aerenchyma. ARS scientists are working with a plant breeder and plant cell morphologist at the University of Georgia at Athens and other scientists to breed new commercial wheat varieties that, like rice, will develop aerenchyma in their roots soon after sprouting, instead of waiting for flooding.

Southern Piedmont Conservation Research Laboratory, Watkinsville, GA.

James E. Box, Jr., (706) 769-5631

Repair genes in moss may hold the key that enables crops to recover from lengthy, crippling droughts.

ARS scientists believe they have found some of the repair genes that help star moss, *Tortula ruralis*, survive total desiccation for months, then revive seconds after being hit by drops of water. The moss recovers so quickly because, as it starts to dry, it stockpiles the genetic material it will use to make repair proteins when it rains. The scientists have isolated many of the genes active during the moss' recovery stage and have focused on one, initially, because of its similarity to other genes known to operate after dehydration damage in seeds. They are also collaborating with Australian scientists to identify similar drought-tolerant genes in the livestock forage grass, *Sporobolus stapfianus*. This grass protects itself against almost total dehydration. In this case, the scientists are also looking for the genes that protect the grass tissue as it dries.

Plant Stress and Water Conservation Research, Lubbock, TX

Mel Oliver, (806) 746-5353

IPM/Biological Control

A natural fungus could be a new weapon against insects that infest stored grain. *Beauveria bassiana* had a success rate of 80 to 100 percent in killing invading insects in preliminary lab tests. ARS scientists are investigating it as a biocontrol against rice weevils, lesser grain borers and red flour beetles. These insects—primarily during their immature, wormlike stage—can ruin stored rice, corn, wheat and sorghum. Currently, chemical insecticides are growers' main recourse, but some registrations are scheduled to be withdrawn. ARS scientists envision *Beauveria* as a potential alternative. In their experiments, the fungus killed the adult insects within two to four weeks after infecting them. But the fungus doesn't grow on the stored grain and is harmless to humans and animals. For tests, scientists incorporated the fungus into a powder. They then mixed the powder with brown and long-grain rice in containers simulating storage bins. Next they released adult insects into the containers for up to 21 days. Results: the insect kill-rate of 80 to 100 percent. Scientists caution further research is needed, particularly to find how it can be formulated. Ideally, *Beauveria* could be deployed to squelch the first infestation of adult insects. This would greatly reduce numbers of a succeeding generation of wormlike offspring.

Rice Research Unit, Beaumont, TX

Robert Cogburn/William Rice, (409) 260-9343/(318) 788-7553, wrice@lsuvm.sncc.lsu.edu

A natural fungus could even the odds against common cocklebur, a tall, bushy weed that bullies smaller soybean plants in competing for sunlight and nutrients. Many herbicides don't control cocklebur infestations, which can cause soybean yield losses of up to 80 percent. ARS scientists hope to curb its destruction with the fungus *Alternaria helianthi*. They discovered, in greenhouse studies, that the fungus causes a blight disease that killed over 90 percent of cocklebur seedlings in seven days. Researchers have since tested the fungus against 12 different strains of the weed. They plan field studies and are testing a water-corn oil formula that helps the fungus more easily infect the weed and bolsters its killing power. Success of the experiments could encourage agri-chemical companies to formulate it as a "bioherbicide" for protecting soybean, cotton and other crops.

*Southern Weed Science Laboratory, Stoneville, MS
Hamed K. Abbas, (601) 686-5313, habbas@ag.gov*

Crop Productivity

It's known that chilly evenings can cause biochemical chaos in warm-weather plants like tomatoes and corn, resulting in reduced yields. But ARS researchers say that manipulating certain plant enzymes could keep crop biochemistry on an orderly schedule. If the researchers succeed, the same tactic may also expand the geographic area in which some warm-weather plants are grown. Crucial processes that normally take place at night in the plant may shut down when temperatures dip below 50 degrees F. When the weather warms up in the morning, the nighttime processes resume. But they may clash with different, but equally important processes set to occur during the day. ARS researchers have determined that the two enzymes play a key role in turning on and off central biochemical activities. Their aim is to manipulate the enzymes sucrose phosphate synthase and nitrate reductase to override nature's obsession with temperature.

*Photosynthesis Research Unit, Urbana, IL
Don Ort, (217) 333-2093*

Growers will soon have four new selections of commercially available blueberries to choose from. Little Giant—bred for the cooler climates of Washington, Oregon, Michigan, New Jersey and North Carolina—offers an alternative variety for frozen and processing markets, and should be planted with other northern highbush blueberry varieties for cross pollination. Pearl River, Magnolia, and Jubilee are new varieties and more suited to the warmer climates in the Gulf Coast and Southeastern United States. They should be interplanted with other southern highbush blueberry varieties to

ensure fruit set, early ripening and maximum yield. Each of the four new varieties is productive and disease resistant. Plants are available in season at nurseries.

Blueberry & Cranberry Research Center, Chatsworth, NJ

Mark K. Ehlenfeldt, (609) 726-1590

Small Fruit Research Station, Poplarville, MS

James M. Spiers, (601) 795-8751

Two new June-bearing strawberries have been introduced by ARS plant breeders for the Middle Atlantic and adjacent regions. Primetime, a mid-season berry, bears fancy, good quality, large fruit. Latestar, a late-season variety, has large, attractive fruit. Both varieties are recommended for shipping and local markets and resist multiple fungal diseases. They produce well on either light or heavy soils, and in matted rows or in hill culture. Plants are available in season at nurseries.

Fruit Laboratory, Beltsville, MD

Gene Galletta, (301) 504-5652

Potato farmers could save on fertilizer—and cut yield losses from a fungus—by rotating their potato crops with one of these nitrogen-fixing legumes: hairy vetch, alfalfa or white lupin. ARS scientists conducted a two-year field study with the legumes. Maine potato farmers, who typically don't use cover crops, must apply 120 to 200 pounds of nitrogen fertilizer per acre, depending on the potato variety. But the researchers showed that planting one of the legumes allows reducing the rate without sacrificing yield. Legumes take nitrogen from the air and store it in nodules on their roots. After the legumes die and their roots decay, the next potato crop can use this nitrogen for growth. In the ARS study, hairy vetch replaced nearly 60 pounds of nitrogen fertilizer per acre; alfalfa, about 40 pounds; and lupin, 20 pounds. The study also revealed that growing a legume disrupted the life cycle in the soil of a *Rhizoctonia* fungus, the culprit behind yield-damaging lesions on potato plant stems. When one potato crop followed another, nearly 60 percent of the plant stems had lesions. Rotating potato with alfalfa cut this to 12 percent.

*New England Plant, Soil and Water Laboratory,
Orono, ME*

*C. Wayne Honeycutt, (207) 581-3363,
honeycutt@maine.maine.edu*

Sugarbeet breeders can now get two new ARS-developed sugarbeet lines that combine resistance to the three diseases that cause nearly all disease damage to beets worldwide. Resistance of both new lines is excellent against *Rhizoctonia* root rot, and moderate against curly top and *Cercospora* leaf spot. Individual commercial varieties may be highly resistant to one or another of the three diseases. But the new lines—named

FC721 and FC721CMS—contain better resistance against an onslaught of all three diseases. ARS and the Beet Sugar Development Foundation jointly released the lines after testing by ARS researchers in Fort Collins, CO, and Kimberly, ID. Commercial breeders can obtain seed from ARS.

*Crops Research Laboratory, Fort Collins, CO
Lee Panella, (970) 498-4230*

A commercially available insect growth regulator, fenoxycarb, works on a number of different insects, including fire ants, cockroaches and caterpillars in a variety of agricultural, range and urban habitats. Now the compound is being used to control pear psylla, the most severe insect pest of pears in the Pacific Northwest. In orchard tests in 1995, ARS scientists found that a single application in mid-March killed up to half the pear psylla eggs and reduced densities of second generation psylla below damaging levels. Because fenoxycarb appears to have much less of an effect on natural enemies, it also allowed a slow buildup of predators and parasites. But its effectiveness was reduced during 1996 because of a cool spring and two applications were needed. In both years, trees not sprayed with fenoxycarb had extremely high pear psylla infestations, requiring summer applications of insecticides. Scientists are helping growers incorporate the technique into a large, area-wide, integrated pest management program aimed at reducing insect problems while reducing insecticide use.

*Fruit and Vegetable Insect Laboratory, Wapato, WA
David R. Horton, (509) 454-6550*

Wild species of sunflowers might provide their cultivated cousins with genes for such valuable traits as drought tolerance or disease resistance. Until recently, embryos of most crosses between cultivated sunflowers and wild species wouldn't develop into fertile plants. Now scientists have broken the interbreeding barrier for at least nine difficult-to-cross species by first growing a meager portion of the hybrid embryos on a new tissue-culturing medium. Then the researchers treat the "rescued" embryos with the chemical colchicine to double the number of chromosomes in reproductive cells. Plants called amphiploids are produced from these male and female reproductive cells with doubled chromosomes. These amphiploids of interspecies hybrids are genetically compatible with other sunflowers used in breeding experiments.

*Oilseeds Research, Fargo, ND
C.C. Jan, (701) 239-1319*

A new irrigation aid automatically blocks unwanted surges in water pressure to help farmers avoid applying too much water to their crops. An ARS scientist invented and patented the lightweight, low-

maintenance irrigation pressure regulator. It can easily be installed in several kinds of pressurized irrigation systems, including buried drip or surface drip and lateral move or center pivot sprinklers. Key components of the new device are an air cylinder and spring that close a butterfly valve in the irrigation pipe when water pressure exceeds the target set by the grower. The regulator is simpler and cheaper than some other options for controlling water pressure. It could prove ideal for some of the 11 million acres of irrigated farmland in the United States that are hilly enough to warrant pressure control valves. The apparatus is appropriate for pipes or conduits that measure two to 12 inches in diameter, carry flows of 25 to 2,500 gallons per minute, and handle pressures of 5 to 90 pounds per square inch. A computer spreadsheet program from ARS assists valve manufacturers or irrigation system designers in calculating the correct size and settings for the spring and cylinder. (PATENT 5,509,449)

*Northwest Irrigation and Soils Research Laboratory,
Kimberly, ID
Dennis C. Kincaid, (208) 423-6503*

Seed testers should monitor the water temperature when judging the seed quality of winter wheat and other plants. The temperature of the water that moistens a sample of planted seed may be more important than previously thought. ARS scientists have discovered important exceptions to the general rule that crops germinate and grow best after planted seeds absorb water at 68 to 86 degrees F. These temperatures turned out to be detrimental to germination and seedling growth of winter wheat and rangeland shrubs like sagebrush and kochia. These plants do better when seeds soak up water at 41 to 59 degrees. Research also showed that age of the seed affects optimal water temperature. For winterfat, old seed showed increased vigor at cooler water temperatures. Based on observations of 11 crop and shrub species, scientists recommend that guidelines be developed for each important plant species. The guidelines would be incorporated into seed testing procedures recommended by the Association of Official Seed Analysts, International Seed Testing Association and similar organizations charged with seed quality testing.

*High Plains Grasslands Research Station, Cheyenne, WY
D. Terrance Booth, (307) 772-2433*

Crop Diseases and Pests

DNA fingerprinting has revealed that the primary cause of recent late blight epidemics of U.S. and Canadian potato and tomato plants are new genotypes of the fungus *Phytophthora* introduced from Mexico.

Late blight, a disease caused by one of the more than 50 species of *Phytophthora*, is one of the most destructive plant diseases known. It caused the Irish potato famine in the 1840's. In 1994 alone, U.S. potato and tomato crop losses from late blight were estimated at over \$100 million, and another \$100 million or more was spent to control the disease. ARS and Cornell University scientists tested 251 isolates of *P. infestans* for their sensitivity to the fungicide metalaxyl that usually controls the late blight pathogen. The isolates came from 15 states and one Canadian province from 1987 through 1993. Analyses with molecular markers revealed the primary cause of these epidemics was new, recently introduced genotypes of the fungus—most likely from northwestern Mexico. Resistance to metalaxyl was detected at about the same time as the migrations occurred. Field experiments confirmed that metalaxyl alone has no effect on the new, resistant genotypes. Since resistance to metalaxyl was almost certainly introduced, there was nothing U.S. potato growers could have done to prevent its occurrence. Seed potatoes should be monitored for the new genotypes to limit their migration and fields containing them should not be sprayed with metalaxyl.

Crop Production and Pest Control Research, West Lafayette, IN

Stephen Goodwin, (317) 494-4635

A new test has been developed to screen geraniums for newly discovered viruses. Geraniums are one of the most rapidly expanding ornamental garden crops in the United States. From 1970 to 1990, total U.S. potted geranium sales increased from \$25 to over \$130 million, with an additional \$30 million for bedding geraniums in 1990. Since geraniums are propagated mainly from cuttings, more than fifteen different viral diseases threaten their production and quality, severely reducing vegetative growth and plant and flower quality. Often mixed viral infections cause severe disease, causing confusion about the exact identity of the culprit. ARS scientists isolated two of the top four viruses from geraniums. After studying their biological, biochemical and serological properties, the scientists called them pelargonium line pattern virus and ringspot virus. Next, they developed a polyclonal antisera to these viruses and showed they can detect the viruses in infected geranium. The new tests will help the U.S. potted plant industry since both exported and imported geraniums have to be virus free.

U.S. National Arboretum, Beltsville, MD

Ramon L. Jordan, (301) 504-5670

A fly new to science was discovered infesting the flower buds of a native azalea, called pinxterbloom. This valuable ornamental (*Rhododendron periclymenoides*) develops pink blooms in late spring in the Washington, DC, area. An ARS scientist named the

tiny new gall midge (*Dasineura praecox*) and characterized it anatomically and biologically so it can be readily identified and controlled. In spring, the fly larvae live among flower parts in the newly burgeoning azalea buds. Their salivary secretions cause the buds to remain closed and provide food for the larvae, instead of developing fully into flowers. Around the end of April, when uninfested flowers are beginning to open, fully developed larvae crawl out of aborted buds, drop to the ground, burrow into the soil and form cocoons. They remain there until September when they change into short-lived flies that lay eggs inside the next season's buds. Larvae develop into eggs but remain encased until the following February when they hatch and begin to feed. Scientists do not know whether the new pest is native and has gone undiscovered or a new accidentally introduced fly from abroad. Their information will be used by scientists working to control azalea pests and to plant inspectors at ports of entry charged with identifying alien insect pests.

Systematic Entomology Laboratory, Washington, DC
Raymond Gagne, (202) 382-1796

Common barberry is making a comeback in the north-central states—which is bad news for crops. That's because common barberry, *Berberis vulgaris*, is an alternate host for wheat stem rust, and its presence puts vulnerable crops like wheat, oats and barley at greater risk of rust infection. Barberry bushes were identified as the primary source of new stem rust races before a nationwide eradication program was initiated to remove them. More than 100 million barberry bushes were destroyed between 1918 and 1975. However, it is re-emerging in wooded areas of Wisconsin and Minnesota. Birds spread barberry seeds by eating berries that grow on the bushes. Barberry growing at or near the edge of wooded areas are more likely to be visited by birds. ARS researchers are keeping tabs on new barberry growth, and are continuing efforts to breed wheat varieties with increased rust resistance. A resurgence in barberry populations could complicate efforts to develop rust resistant varieties of wheat, oats and barley. *Berberis vulgaris* has not been used as an ornamental shrub since eradication began. Nationally, the horticulture industry cooperated by removing the bush from ornamental stocks.

Cereal Rust Laboratory, St. Paul, MN

Dave Long, (612) 625-1284

A new test detects and identifies in only one to two days the agent that causes chrysanthemum stunt, an economically important disease worldwide. Such a fast technique can be used for large scale screening of the disease in quarantine procedures and plant certification. Caused by the chrysanthemum stunt viroid (CSVd), the disease now can take two to six months to

detect by screening plants biologically. ARS scientists developed a test relying on a rapid, sensitive molecular technique called polymerase chain reaction. An analysis is completed from a billion copies of a fragment of DNA from sap or nucleic acid extracts of infected dried or fresh leaves. CSVd can also be detected from infected tissue by another molecular technique called tissue blot hybridization. Thin cross sections of chrysanthemum leaf petioles and stem internodes are pressed against a nylon membrane. The membrane is hybridized with a non-radioactive probe for CSVd and then the hybridized products are visualized on film. PCR and tissue blot hybridization eliminate the need to use radioactive material.

*National Germplasm Resources Laboratory,
Beltsville, MD.*

Ahmed Hadidi, (301) 504-6460

A new, accurate and sensitive test confirms the connection between superficial scald, a disease that attacks stored apples, and levels of farnesene, a compound found in apple peels. Farnesene breaks down into trienol, which is toxic to the fruit. Stored Granny Smith apples easily succumb to scald, which blackens the fruit and makes it unmarketable, but Gala apples aren't as susceptible. Using the new tests on fruit stored for up to four months, ARS researchers showed levels of farnesene and trienol were 20 times higher in Granny Smith than in Gala. Another finding: Decreasing oxygen levels could increase apple shelf life. That's because when oxygen levels in storage go up, both farnesene and trienol increase, but boosts in trienol are more closely correlated with oxygen concentration. Stored under 100 percent oxygen, Granny Smith fruit were completely covered with scald after three months.

*Horticultural Crops Quality Laboratory, Beltsville,
MD*

Bruce D. Whitaker, (301) 504-6128

Researchers have pinpointed the genes that help some corn plants naturally fend off *Phaeosphaeria mayis*, a crop-damaging fungus found mainly in Brazil. Although limited outbreaks of the fungus have occurred in Florida the past four years, *P. mayis* has never gained a solid foothold in the United States. But there is a potential problem: Iowa Stiff Stalk Synthetic, a favored breeding population for domestic corn hybrids, has some "family members" that are vulnerable to *P. mayis*. By knowing which genes provide resistance, plant breeders now can ensure new corn hybrids aren't vulnerable. Also, varieties now in development can be checked for possible susceptibility. ARS researchers were first to identify the fungus in the United States. *P. mayis* can slash yields and leave tell-tale gray rings on plant leaves.

Plant Science Research, Raleigh, NC

Martin L. Carson, (919) 515-3516

One hot spring day can mean the difference between a weed "sweet dream" and a nightmare. A two-year study of several weed species from Ohio to Colorado and Missouri to Minnesota showed that each species has a different weather trigger that prevents seeds from sprouting. Scientists found this trigger an important reason why weed sprouting varies each spring, typically from one- to 100-percent of the buried seed. For example, if the top inch of soil warmed to about 90 degrees F for only a single day in April, giant foxtail seeds went into dormancy, refusing to sprout for the rest of the season. Dry soil in the spring induces a similar all-season dormancy for pigweed seed, which is why pigweed was a major problem in areas that had a wet spring this year, such as west central Minnesota. The discovery also helps the ARS weed simulation computer model, called WeedCast, to more accurately forecast each weed season. The forecasts can be used with the WeedSim model that helps farmers reduce herbicide use by advising them when it's not needed.

Soil Management Research, Morris, MN

Frank Forcella, (320) 589-3411

Animal Productivity

Mathematics may hold the answer to how much of a dairy goat's observed traits are the result of genetics versus environment. Researchers devised a formula that describes the genetic and environmental components of conformation traits such as a goat's strength, stature, and udder shape. The equation even separates temporary environmental factors such as seasons from permanent ones such as injury. It considers the influence of all the animal's relatives—not just the sire, as in other models—and provides insights into heredity's role. Least likely to be influenced by genetics are rear udder arch and rear legs. But stature, teat diameter and placement are highly heritable. By accurately estimating the heritability of valued traits, breeders may be better able to calculate dairy goats' genetic merit. Researchers developed the formula using data from the American Dairy Goat Association. Records from 154 herds and six breeds were used, and pedigrees were included for animals born in 1978 or later.

*Animal Improvement Programs Laboratory,
Beltsville, MD*

Suzanne Hubbard/George Wiggans, (301) 504-8334

Cattle breeders who screen young bulls for potential natural-mating fertility by measuring testicle size and semen quality may soon be adding another criterion—scrotal temperatures. Using an infrared camera-like device, scientists measured 73 bulls' scrotal surface temperatures in a pattern from top to bottom of each testis. Surface temperatures typically were 1.5 to three

degrees warmer at the top of the scrotum than at the bottom. In a 45-day breeding test, a typical 14-month-old bull with a uniform progression of decreasing scrotal surface temperatures impregnated 15 of 18 heifers. In contrast, bulls that didn't have this uniform temperature pattern impregnated about 16 percent fewer.

*U.S. Meat Animal Research Center, Clay Center, NE
Donald D. Lunstra, (402) 762-4188*

Animal Diseases and Pests

A virus that causes intestinal disease and death in young pigs has been found to survive longer than currently used decontamination schedules. Transmissible gastroenteritis virus (TGEV) costs the U.S. pig industry more than \$100 million a year. Sows infected with TGEV pass the virus on to their nursing piglets, causing intestinal disorders that can kill the young pigs. Those that survive require longer to reach market weight. Typically, pigs are removed from farrowing houses for four weeks while the houses are decontaminated. Now ARS researchers suspect the virus may survive longer than four weeks. In laboratory studies, they demonstrated that some pigs infected with TGEV can shed the virus in their feces up to 18 months. This information is needed by farrowing house managers to adopt new management practices to eliminate TGEV from farrowing houses. Pigs with TGEV virus cannot be sold to export markets.

*Virology Swine Research, Ames, IA
Roger D. Woods, (515) 239-8358*

A newly recognized bacteria that sickens swine may prove even more costly to pork producers than its look-alike cousin, the bacterial culprit behind swine dysentery. ARS researchers recently assisted an Australian student in describing and naming the new bacterium, *Serpulina pilosicoli*. This is the first time it's been distinguished from *S. hyodysenteria*, which causes swine dysentery and an estimated \$100 million annually in losses to pork producers. The new bacterium's name, officially accepted in January 1996, means "little serpent of the hairy colon." The researchers have developed diagnostic tests to distinguish the various *Serpulina* bacteria known to cause intestinal diarrhea in pigs and humans.

*Enteric Diseases and Food Safety Research, Ames, IA
Thaddeus B. Stanton/Neil S. Jensen, (515) 239-8495*

Contrary to conventional wisdom, cold pond water doesn't necessarily have a chilling effect on a vaccinated fish's ability to retain immunity against enteric septicemia of catfish (ESC). In field tests, catfish received a live vaccine against *Edwardsiella ictaluri*, the pond-dwelling bacterium that causes ESC. The fish then were grown in water temperatures of either 66.2 degrees

F or 78.8 degrees. The fish were challenged monthly with exposure to *E. ictaluri* for four months. The conclusion: Immunized fish in the colder water were no more likely to become infected than their counterparts in warmer water. These findings give catfish farmers a wider window of opportunity in which to vaccinate their fish against ESC, a costly disease that can kill up to half of catfish in infected ponds.

*Fish Diseases and Parasites Laboratory, Auburn, AL
Phillip H. Klesius, (334) 887-4526*

A new system developed by ARS scientists cleans up fish farming wastewater and gives greenhouse growers a more efficient and productive way to produce cash crops from that wastewater. The wastewater is loaded with nutrients like phosphorus, needed by plants for growth. In troughs that carry wastewater, researchers placed young plants near the beginning of the water flow where nutrients are highest, moving the plants further down the trough as they matured. Young lettuce and basil plants absorbed and stored more nutrients than they needed—a process called luxury consumption—at the front end of the troughs. These surpluses sustained them when they were moved toward the end where the water had been cleaned of most of the nutrients. Luxury consumption allowed the plants to be productive even in water that didn't contain enough nutrients to produce a crop. As mature plants are moved into the cleaner water, young, new plants take their place at the nutrient-rich end of the trough. This system allows maximum productivity from expensive greenhouse space. Also, after the nutrients have been removed from the wastewater by the plants, the clean water can be used on other crops.

Appalachian Fruit Research Station, Kearneysville, WV

Paul R. Adler, (304) 725-3451

A viral gene dubbed 23-NL could lead researchers closer to a vaccine for African swine fever (ASF). Researchers have found that the gene appears to be a key player in the worst ravages of this often deadly disease of swine. When the 23-NL gene is removed from highly virulent ASF strains, the virus can still infect but will no longer kill pigs. Also of interest: The gene-deleted virus takes longer to make its appearance in the pig. This suggests the gene is involved in the virus' ability to reproduce itself in critical target cells, such as the animal's lymph nodes and spleen. While the United States has never had an outbreak of ASF, the virus has flared up in Europe, Central and South America and Cuba, often resulting in the slaughter of all swine in the infected area. The virus has found its way into many countries via the feeding of ASF-infected meat products in garbage to pigs. Experiments have shown viable ASF

virus can survive in salted, dried meat products for as long as 10 months.

*African Swine Fever Research, Plum Island, NY
Dan Rock, (516) 323-2500*

A new diagnostic test uses proteins from the organism *Neospora caninum* to reveal whether an animal is infected with this newly discovered, costly parasite. *N. caninum* may be the culprit behind up to half of all cattle abortions. Existing tests to unmask *N. caninum* required growing the entire parasite in culture—a time-consuming and costly procedure. The new test relies on antigens, proteins produced by the parasite that cause an animal's immune system to make antibodies. Purified antigens are mixed with blood from animals thought to be infected. If the blood contains antibodies to *N. caninum*—indicating infection—the purified antigens will bind to the blood sample. Then, a second antibody is added that contains an enzyme that changes color if the blood is infected. The purified antigens are mass-produced in fast-growing *E. coli* bacteria and the final diagnostic procedure can be automated to check dozens of samples per minute. Researchers say the new test could be available commercially within the next two to three years.

*Immunology and Disease Resistance Laboratory,
Beltsville, MD*

Mark C. Jenkins, (301) 504-8054

A new test warns feed processors if poultry meal is contaminated with gizzerosine, a chemical substance that can sicken poultry by eroding their gizzards. The condition is known commonly as black vomit disease. Gizzerosine forms during heat processing in making fish-meal, which is a protein source for poultry. The new test detects trace amounts of gizzerosine in fish meal. This is a more precise, less costly procedure than the current method of testing on live chicks. The test also can assist scientists in understanding how the toxin affects chickens by following the metabolism of gizzerosine.

*Growth Biology Laboratory, Beltsville, MD
John McMurtry, (301) 504-8803*

Soil, Water and Air Quality

A multi-fan spray system is under study by ARS researchers to reduce aerial drift of pesticide from orchards and nurseries to nearby fields and neighborhoods. This way, more of the chemical stays where it can suppress fruit-munching insects, fungal blight and diseases that cause millions of dollars in orchard crop losses annually. The system can reduce spray drift by at least 40 percent. It uses fans tilted downward and upward, rather than the conventional axial-flow system

that sprays chemicals in a large fan-like pattern. The system's downward tilted fan more precisely aims pesticides at plant parts. The multi-fan system also is taller than conventional orchard sprayers, for better coverage on the top side of fruit trees.

*Application Technology Research Laboratory,
Wooster, OH*

Ross Brazee, (216) 263-3870

On rangeland where no livestock has grazed, one might assume the soil would be healthier. Not so, according to an ARS study of two measurements of soil health—organic carbon and nitrogen. Scientists compared grazed land to range that had been left free of livestock for 40 years. On ungrazed pastures, the scientists found more carbon and nitrogen were "tied up" in dead plant material that breaks down and blows away. By contrast, grazed areas retained over 30 percent more carbon and nitrogen in the top three inches and about 15 percent more in the second three inches. Below six inches, there was little difference in carbon and nitrogen between soils under grazing or ungrazed rangeland. Grazing cattle trample the plant material into small pieces, helping it decompose and mix into soil. In addition, they add manure which is rich in plant nutrients. Scientists compared grazing plots on short- and mixed-grass rangelands that are representative of more than 300 million acres in the West. This study of soil nutrients was part of continuing efforts to understand and find ways to improve or sustain valuable grazing lands.

High Plains Grasslands Research Station, Cheyenne, WY

Richard H. Hart, (307) 772-2433

Just how well earthworms can enrich soil quality depends on what they eat. ARS tests confirmed that the type of crop makes a difference—earthworms feeding in soybean fields deposit a higher concentration of nitrogen and protein than those eating in corn fields. Earthworms (*Lumbricus terrestris*) take in the nutrients from munching on crop residues plus microbes feeding on plant parts. The worms then excrete a substance loaded with carbon, nitrogen and other nutrients that are more readily used by crops for growth. Another finding from the soil tests: Reduced tillage means more worms. That's because less tillage leaves more organic matter for worms to consume.

*Soil and Water Management Research, St. Paul, MN
Dennis Linden, 612-625-6798*

Sagebrush seedlings have a better chance at surviving on reclaimed mining land if seeds are planted according to new guidelines developed by ARS scientists. The guidelines also will help ensure compliance with

federal and state strip mine laws that require disturbed lands to be restored to their original condition. This requirement applies to all native species including shrubs like sagebrush. ARS scientists found that the key elements for survival of sagebrush seedlings are: (1) store seed at room temperature and humidify for up to six months before seeding; (2) reseed using topsoil recently removed from an adjacent mining area; (3) use the heaviest seed available, and (4) provide mulch. Sagebrush species and sub-species are the most abundant native shrub in North America, growing on about 420,000 square miles of rangeland in 11 western states. The shrubs provide a good source of winter protein for wildlife, and ranchers value the nutrients that the plants supply to cattle, especially during winter or extended drought.

High Plains Grasslands Research Station, Cheyenne, WY

D. Terrance Booth/Gerald E. Schuman, (307) 772-2433

Computer Systems and Models

Using the "SCS-Scheduler" irrigation program, a Texas farmer raised corn, sorghum and wheat yields by at least 25 percent over county averages in a three-year ARS-sponsored test. For example, in 1993, Scheduler-irrigated corn yielded an average of 199 bushels an acre, compared to that year's county average of 157 bushels—an increase of 27 percent. The computer program uses temperature and other data collected from field weather stations to predict the need for irrigating—even before plants show visible damage. It was developed jointly by ARS and by USDA's Natural Resources Conservation Service (formerly the Soil Conservation Service). Another benefit: in June 1992, the Scheduler alerted scientists that prolonged hot weather had speeded up corn growth, requiring an earlier than usual irrigation to save yields.

Water Management Research, Bushland, TX
Terry Howell, (806) 356-5775

Average annual soil loss can be predicted more accurately using a new weather generator program along with the Water Erosion Prediction Project (WEPP). The WEPP program for predicting erosion at a given location is sensitive to local weather conditions. Although this feature has advantages in certain situations, it causes problems when trying to determine erosion trends over a large area because weather data are available only at a limited number of sites. ARS scientists developed a program that, when used with WEPP and the weather generator model Climate Generator (CLIGEN), gives accurate predictions of erosion trends

over large geographic areas. CLIGEN was developed by ARS scientists at the same time as WEPP. CLIGEN averages climate parameters of the station under consideration with the parameters of the surrounding stations. Results from ARS computer simulation studies, using National Weather Service data and the CLIGEN model were consistent with those obtained using other prediction tools like the Revised Universal Soil Loss Equation. This new procedure allows the user to take advantage of WEPP's flexibility over other prediction tools to determine regional trends that are independent of local weather characteristics. The CLIGEN model is now available as part of WEPP as well as on the Internet at <http://soils.ecn.purdue.edu:20002>

National Soil Erosion Research Laboratory, West Lafayette, IN

Mark Nearing, (317) 494-8683

Daily weed forecasts via computer can help farmers reduce herbicide use without yield loss. ARS scientists have posted weed forecasts for west central Minnesota farmers on the Internet, using predictions made by a weed simulation computer model called WeedCast. Scientists are working to put the model on the Internet so farmers worldwide can generate forecasts by typing in local weather data. ARS is also putting the model on computer disks. The forecasts can also be used with the WeedSim model which advises farmers if and when to use herbicides based on predicted weed emergence and subsequent growth. Minnesota field tests with corn and soybeans over the past four years have shown that these predictions can cut herbicide use by more than two-thirds—a potential savings of \$20 an acre. The tests show that a little extra weediness at certain times does not hurt yields. WeedCast forecasts on the Internet are at: <http://www.mrsars.usda.gov>.

Soil Management Research, Morris, MN
Frank Forcella, (320) 589-3411

ARS has helped establish a weather station network that links farmers on Texas' Northern High Plains by fax and computer to the latest forecasts of plant water needs, potentially saving the owner of a 2,500-acre farm more than \$10,000 a year in water costs. Air and soil temperature and other hourly weather data are automatically sent from the field weather stations to a central computer that predicts soil moisture evaporation and plant water use for major crop varieties, based on ARS research. Eventually, computer predictions of pest conditions will be provided to farmers. The eight field stations, each on a private farm in a different county, complement a similar network established for the Texas Southern High Plains cotton farming area. Together, the networks now serve cotton, corn, wheat and peanut farming areas. The Northern Plains network is operated by the Texas Agricultural Experiment Station at Ama-

rillo, Texas, while the Southern Plains network is headquartered at Lubbock. Like Lubbock, the Amarillo station has a computer that automatically sends early morning faxes and e-mail messages to subscribers. They include farmers, county agents, the news media and urban users such as the Amarillo Independent School District. Farmers currently use the network to schedule irrigations, choose planting dates and predict crop growth. The school district uses the forecasts to properly water school landscaping. Corn and wheat farming associations along with local water districts and the Texas Agricultural Extension Service helped build the networks.

Water Management Research, Bushland, TX
Terry Howell, (806) 356-5775

It's known that sunflower plants whose stems stay green longer stand up better to drought and diseases and resist lodging. Now researchers have used an image processing computer system to pinpoint a combination of genes that control the stay-green trait. Their studies with offspring of different male and female inbred sunflower lines indicate breeders can begin selecting for the trait in the early stages of developing new cultivars. Sunflower seeds typically are left to dry in the field, but growers watched for green stems to turn brown as an indicator that seed moisture levels were right for harvesting. Seeds from plants with the stay-green trait become dry enough for harvest before the stems turn brown, resulting in much healthier plants which resist diseases and lodging.

Oilseeds Research, Fargo, ND
Jerry F. Miller, (701) 239-1321

Industrial (Non-food) Products

A new alfalfa type may feed cattle and power electrical generators in Minnesota by the turn of the century. ARS researchers developing the alfalfa say its extra thick and long stems can be burned to help fuel electricity-generating plants, while the leaves can be ground into livestock feed. Another plus: Since alfalfa is a legume, capable of transforming atmospheric nitrogen into a form that enriches the soil, using it in a crop rotation system will leave fields more fertile for other crops. The new alfalfa will be grown and marketed by local farmers, including a newly formed farmers' cooperative in Minnesota.

Plant Science Research Unit, St. Paul, MN
Carroll Vance, (612) 625-1991

Liquid waxes from inexpensive, surplus soybeans could replace sperm whale oil in products as diverse as luxury soaps, insecticide carriers, leather preservatives, lamp oil and even artificial flavorings. Re-

searchers extracted oleic acid from soybean oil, isolated bacteria from the *Acinetobacter* family, and fed the oleic acid to the bacteria. The microbes turned some of the acid into alcohol, then linked the alcohol and remaining oleic acid to form the liquid waxes. Economists predict there could be about 185 million bushels of surplus soybeans available from the 1996-97 crop year.

National Center for Agricultural Utilization Research, Peoria, IL
Larry K. Nakamura, (309) 681-6395

ARS scientists solved a cloudy mystery about meadowfoam oil—and saved meadowfoam processors some \$2 million in potential lost sales. Meadowfoam oil is a rich source of unique long-chain fatty acids that can be made into cosmetics. But oil from the 1993 and 1994 crops contained an unknown substance that gave it a cloudy appearance and made it undesirable for cosmetic manufacturers. ARS researchers identified the substance as a harmless seedcoat wax and devised a technique to remove it from the oil by cooling and filtration.

National Center for Agricultural Utilization Research, Peoria, IL
Terry A. Isbell, (309) 681-6235

Two simple planting and fertilizing tips for lesquerella could boost yields and profits from this promising industrial crop for farmers in arid southwestern states. Lesquerella seed oil has potential for many uses in cosmetics, and for high-quality lubricants that could replace those made exclusively with imported castor oil. Applying nitrogen fertilizer at 55 to 110 pounds per acre resulted in maximum seed yields. Also, in cooperative field studies with the University of Arizona, ARS scientists found that lesquerella crops yield more seed if planted in September rather than October, November or February. However, because of higher priced irrigation water during September, this tip doesn't apply to some areas of Arizona.

U.S. Water Conservation Laboratory, Phoenix, AZ
David A. Dierig, (602) 379-4356

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Quarterly Report

of Selected Research Projects

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Into the Marketplace

...With TransFRESH Corp., Salinas, CA, to develop a method for suffocating Mexican fruit flies trying to hitch a ride in grapefruit shipments. Fly invasions can trigger costly eradication programs requiring aerial sprays of insecticide. Plus, the pests can devastate farm production and trade, because quarantines must usually be imposed to prevent their spread. Methyl bromide is the most common quarantine treatment available for grapefruit and other citrus. But this pesticide is slated to be phased out by 2001 for environmental reasons. A promising alternative is a method called CA—controlled atmosphere. A dramatically altered but precisely determined balance of air's three main gases—oxygen, nitrogen and carbon dioxide—is pumped into a shipping container carrying fruit. The fruit flies suffocate because the atmosphere holds less than 1 percent oxygen instead of normal air's 20.9 percent. ARS scientists

Contact the scientists listed for further information on each research project. For general questions about this report, contact Sean Adams, ARS Information, 6303 Ivy Lane, 4th Floor, Greenbelt, MD 20770, (301) 344-2723, sadams@asrr.arsusda.gov

Items marked with the word PATENT are being patented by ARS. For more information on patents, CRADAs and patent licenses, contact ARS Office of Technology Transfer, Bldg. 005, Rm. 416, BARC-West, Beltsville, MD 20705, (301) 504-5734. Questions about a company's product and/or research should be directed to the company itself.

This publication is available on the ARS Home Page at <http://www.ars.usda.gov/lis/>

have seen promising results from lab tests with more than 100,000 fruit flies and 5,000 grapefruit. In some tests, all the flies died in 1 to 3 days without compromising fruit quality. An effective CA method would give shippers a new, in-transit insurance policy: Even if Mexican fruit flies are found infesting a growing area, CA would stop them from surviving the trip to a new locale in outgoing fruit shipments—and the shipments could continue. The scientists also are exploring CA as a quarantine treatment for oranges and to preserve the quality of mangoes during shipping. (PATENT APPLICATION 08/543,475)

*Crop Quality and Fruit Insects Research, Weslaco, TX
Robert Mangan, (210) 565-2647*

...With Bio-Cide International, Inc., of Norman, OK, to develop a new weapon against microorganisms that attack potatoes in storage. ARS and Bio-Cide scientists will determine whether a chlorine dioxide-based solution will protect stored tubers from microbes that cause spoilage. Of special concern: A new strain of late blight, caused by *Phytophthora infestans*, may increase stored tubers' susceptibility to rots. Before they are sold in supermarkets or processed into chips, fries or other popular potato products, tubers may spend up to 10 months in storage. In lab and field experiments, ARS food safety scientists in California, a potato researcher with ARS in Idaho, and Bio-Cide researchers will pinpoint safe, effective dosages of the top-performing chlorine dioxide-based mixture. They will also determine optimum conditions for applying it and best techniques for its use by growers and processors. Bio-Cide anticipates regulatory approval by fall 1997.

ARS contact: Lee S. Tsai, Western Regional Research Center, Albany, CA, (510) 559-5878

...With Dry Creek Laboratories, Inc., Modesto, CA, to speed discovery of genes to protect crops—before and after harvest—from harmful fungi. Scientists with Dry Creek and an ARS laboratory in California will scrutinize an experimental potato hybrid. The new hybrid may contain genes for resistance to a new, more virulent strain of a disease called late blight. Caused by the fungus *Phytophthora infestans*, late blight is the most destructive disease of potatoes worldwide. ARS scientist John P. Helgeson in Madison, Wisconsin, developed the hybrid by fusing leaf cells from a late-blight-resistant species of wild potato with leaf cells from a cultivated potato variety. If the California researchers find and clone a resistance gene, they intend

to transfer it to commercial potato varieties. Later experiments could reveal whether this potato gene can safeguard other crops from their worst fungal nightmares. Grapevines, for example, are continually threatened by the *Uncinula necator* fungus that causes powdery mildew. And walnut trees could benefit from a new source of resistance to *Phytophthora* fungi that cause root and crown rots.

ARS Contact: William R. Belknap, Western Regional Research Center, Albany, CA, (510) 559-6072

...With Pegasus Machinery Company, Tucson, AZ, to develop new equipment that would give western U.S. cotton growers a better way to bury leaves, stems and other cotton-plant leftover in fields after harvest. Growers perform these tasks to comply with "plowdown" regulations for destroying wintertime hiding places of pink bollworms and boll weevils. They might be able to do this more effectively—and save energy, reduce tillage costs and minimize soil compaction—when the new apparatus is commercially available. The tractor-mounted equipment would cut plant roots and embed the residue in just one pass across the field, instead of the repeated passes required with some other equipment. Ideally, the invention would also slow the decay of plant residue by burying unshredded stalks in a concentrated band, somewhat like a rope. Scientists think the band might take longer to decompose than typically shredded crop debris. Prolonged decomposition should enrich the soil, a boon for growers in the arid Southwest where high temperatures accelerate decay. A slower rate of decay might also provide a more stable environment for beneficial soil-dwelling microorganisms that fight diseases, nematodes and other cotton enemies.

ARS Contact: Lyle M. Carter, Western Integrated Cropping Systems Research, Shafter, CA, (805) 746-8004

Genetic Resources

Two new grass germplasm lines resist stem rust ten times times more effectively than existing varieties. ARS scientists developed tall fescue line ORTFRR-T94 for use as a turf grass and ORTFRR-F94 as forage. Stem rust became a significant problem for grass seed producers of Oregon's Willamette Valley in 1987. Growers in this valley produce 97 percent of the country's certified tall fescue seed. Now growers spend \$27 million annually on fungicide to control the rust. If unchecked, the rust can reduce grass seed yields by 80 percent. In laboratory tests, more than 50 percent of the plants in the new germplasm lines demonstrated resistance to the rust. Only about 5 percent of the plants in existing commercial cultivars showed this resistance. Field tests are underway. Researchers cross-bred 1,400 plants representing 20 tall fescue cultivars over two generations to develop the two germplasm lines. Small quantities of

seed are available for researchers and industry to further develop the lines into rust-resistant cultivars.

*National Forage Seed Production Research,
Corvallis, OR*

Reed E. Barker, (541) 750-8736

A new corn cultivar with diamond-shaped seeds is ideal for poultry feed. Released by ARS, the new corn—called Chulo—yields about six tons of seed per hectare and resists maize dwarf mosaic virus and most tropical leaf diseases. Chulo blooms in about 55 days and can be grown year-round in the tropics—making it an ideal cultivar in those areas of the world. The new cultivar is well-suited for poultry because its smaller diamond-shaped kernels—half the size of the usual corn kernel—can be fed directly to farm animals. Usually, corn kernels are too big for poultry to eat whole, so the kernels have to be ground into feed—an added expense to farmers. The cultivar was released after six years of selection by ARS researchers in Puerto Rico.

*Tropical Agriculture Research Station, Mayaguez, PR
Antonio Sotomayor-Rios, (787) 831-3435*

A new viburnum, Conoy, was recently selected for the 1997 Gold Medal Award from the Pennsylvania Horticultural Society. The award honors little-known and underused woody plants of exceptional merit. Conoy comes from the same ARS plant breeding program that produced Mohawk, Shasta, and Eskimo—also gold medal winners. Unlike most viburnums that are too large for home landscaping, these superior compact ornamentals, which grow to a height of 5 feet with a 7 foot spread, are ideal for foundation planting, rock gardens, borders and low hedges. They have glossy, dark, semi-evergreen foliage and masses of cream white, snowball-like flowers in spring. The U.S. National Arboretum has one of the world's few viburnum and crape-myrtle breeding programs, and nine of its introductions have been Gold Medal Award winners.

*U.S. National Arboretum, Washington, DC
Tom Elias, (202) 245-4539*

Alfalfa plant cells can be transformed with new genetic material and nurtured into full-grown plants within eight to 12 weeks with a new laboratory technique. Scientists developed the method to speed up development of different types of alfalfa. Alfalfa leaves are sterilized and cut into squares less than half an inch in diameter. Then they are dipped in a mixture containing cells of *Agrobacterium tumefaciens*, a soil bacterium used to carry engineered genes into plant cells. The leaf pieces and bacteria are grown together for several days and then the leaf pieces are placed on a culture medium that contains antibiotics to kill the bacteria and any leaf cells that did not take in the new DNA. Leaf cells that received the new DNA proliferate and are moved to another culture medium that induces the formation of

plant embryos. The embryos are removed and germinated to form alfalfa plants.

Plant Science Research Unit, St. Paul, MN

Deborah Samac, (612) 625-1243

Winged bean, jack bean, velvet bean, snout bean, ringworm bush, and fish poison bean: These aren't exactly household names even among farmers, but they're all sources of agricultural products that could lead to future drugs. They're also part of a special legume collection maintained by USDA's Agricultural Research Service (ARS). The collection contains more than 4,000 accessions that scientists describe as an "unopened medicine chest." These legumes are a central source of experimental plant material for public and private researchers worldwide. Winged bean, for example, has high levels of proteins called lectins, which are used as diagnostic tools in medical research because they bind to certain blood cells. Winged beans also contain erucic acid (an antitumor medication) and polyunsaturated fatty acids that can be used to treat acne and eczema. Another legume in the collection, kudzu, is best known as a prolific but unwanted roadside weed. But it's also a source of a number of chemicals including daidzein (an anti-inflammatory and antimicrobial), daidzin (a cancer preventive) and genistein (an antileukemic). Velvet bean is a source of dopa, which the brain converts into the neurotransmitter dopamine. Reductions in dopamine have been associated with Parkinson's disease, which occurs when dopamine-producing brain cells are destroyed. Velvet bean also contains serotonin, another brain neurotransmitter that may be involved in learning, sleep, and control of moods. Along with their pharmaceutical potential, these legumes also "fix" nitrogen—transforming atmospheric nitrogen into a form plants can use for growth—enriching the soil and making them ideal candidate crops for sustainable agriculture. Some legumes can add up to 500 kilograms of nitrogen per hectare to the soil, alleviating the need for fertilizer and lessening the chance of water pollution.

Plant Genetic Conservation Resources, Griffin, GA

Brad Morris, (770) 229-3253, bmorris@ars-grin.gov

Forty new sorghum lines with drought, insect and disease resistance have been released by ARS and the Texas Agricultural Experiment Station. The releases are the latest in the ongoing Sorghum Conversion Program, in which breeders convert tropical sorghums into varieties that will grow in temperate areas. The key to the program: classical plant breeding that changes the plants' genetic "internal clock." The tropical plants are used to shorter days and warmer climates along the equator. So scientists cross these with plants from temperate areas, creating lines that thrive during the longer days of spring and summer in temperate zones

farther from the equator. The converted lines can also be harvested by combines because they are several feet shorter than the tropical sorghums. The latest group of 40 sorghums come from 13 different countries. In many parts of the world, sorghum is grown as a food crop. In the United States, however, the grain is used primarily as livestock feed and vegetative parts are made into hay and silage. In 1995, 8.2 million acres of sorghum were grown in the United States with an estimated farm value of more than \$1 billion. Seed from the new lines is available to breeders.

Tropical Agriculture Research Station, Mayaguez, PR
Jeff Dahlberg, (787) 831-3435

Saturated fat content is only about 7 percent in seeds of two new soybean breeding lines—less than half the typical 16 percent found in soybean oil. The Food and Drug Administration allows a product to be labeled "low in saturated fat" if it contains no more than one gram of saturated fat per serving. To meet that standard, soybeans must contain no more than 7 percent saturated fat. ARS scientists in North Carolina and Indiana developed the new lines, N94-2575 and C1945. They were bred to contain less palmitic acid—a saturated fat shown to raise LDL cholesterol levels in the blood—and more oleic acid, which has some health benefits. Soybean oil is found in more than 75 percent of the vegetable oils and fats now on the market. N94-2575 is late-maturing and suited for southeastern breeders, while C1945 matures a little earlier to meet the needs of Midwestern breeders.

Soybean and Nitrogen Fixation Research, Raleigh, NC
Joseph W. Burton, (919) 515-2734

Crop Production and Pest Control Research, West Lafayette, IN

James R. Wilcox, (317) 494-8074

Three new snap bean lines that resist key viral and fungal diseases have been released by ARS and university researchers. The germplasm lines, called Beldade-RGMR -4, -5, and -6, have white seeds and flat pods that are about eight inches long. The high-yielding lines resist 87 known races of the bean rust fungus, *Uromyces appendiculatus*. The lines also ward off the strain of bean golden mosaic virus that was discovered in Dade County, Florida in 1993 and that now occurs in Puerto Rico. The lines are the first commercial snap or dry beans developed in the United States that are resistant to the golden mosaic virus. Limited amounts of seed are available to breeders. The lines were released jointly by ARS and the Florida and Puerto Rico Agricultural Experiment Stations.

Molecular Plant Pathology Lab, Beltsville, MD

J. Rennie Stavely, (301) 504-6600

Human Nutrition

Do carotenoids—the bright red, yellow and orange pigments in fruits and vegetables—warrant a Recommended Dietary Allowance? New findings about the thyroid and oxidation could bring researchers closer to answering this question. Two ARS experiments with female volunteers examined the effects of meals low in carotenes. The experiments—one lasting 14 weeks and the other 17 weeks—were the longest and most rigidly controlled low-carotene studies using human volunteers. About a dozen women participated in each study. Thyroxine, a key thyroid hormone, increased when the women ate few carotenes or other carotenoids at meal-times. The finding adds to the few previously known links between carotenes and the thyroid. Researchers also found more evidence suggesting carotenes act as antioxidants to protect the body from harmful oxidation. Antioxidants are thought to help prevent heart attack, stroke and cancer. During the low-carotene stints, researchers recorded several biochemical signs of oxidative damage. For example, they found more carbonyl compounds—breakdown products of oxidation—in the volunteers' blood and breath. The scientists apparently were the first to note these changes in humans in a carotenoid study that featured familiar foods. Later experiments elsewhere found similar results. Further ARS studies will try to shed more light on whether a specific minimum daily intake of carotenoids is important for good health.

Western Human Nutrition Research Center, San Francisco, CA

Betty J. Burri, (415) 556-6285

Older people who get plenty of beta carotene may have a better chance of preventing virus infections or a cancerous growth. A wealth of epidemiological evidence has linked a high intake of green leafy and deep yellow vegetables—both rich in beta carotene—with lower rates of many types of cancer. But recent studies found a higher rate of lung cancer in smokers who took beta carotene supplements. And the supplements did not meet expectations for reducing cancer incidence in the 12-year-long Physicians Health Study led by Harvard researchers. The elderly may be the exception, however. Men over age 65 who took a 50-milligram beta carotene supplement every other day during the 12-year study had natural killer cells that were more active than their counterparts who got a placebo. Natural killer cells—or NK cells—are the immune system's sentinels, ever on watch for viruses and cancer cells. They recognize an enemy immediately and destroy it, using proteins to punch holes in its outer membrane. This activity is thought to be an important component of cancer prevention. So ARS researchers tested NK cell activity in 59 men in the physician study.

Thirty-eight were middle-aged—51 to 64 years—and 21 were elderly—65-86 years. NK cells from the middle-aged men killed cancer cells at about the same rate whether they got beta carotene or the placebo. Among the elderly men, however, the placebo group's NK cells were significantly less active, while the supplement group's cells kept pace with the middle-age group. The beta carotene dosage used in the physicians study is equivalent to eating two regular-size carrots or one and a half sweet potatoes daily.

Jean Mayer USDA Human Nutrition Research Center on Aging at Tufts, Boston, MA

Simin Nikbin Meydani, (617) 556-3129, s_meydani_im@hnrc.tufts.edu

Ounce for ounce, blueberries, Concord grape juice, strawberries, kale and spinach had the most potent antioxidant activity of 40 fruits, juices and vegetables measured in a "test tube" assay. Health professionals believe that oxygen free radicals, generated by the body's own metabolism as well as environmental pollutants, cause wear and tear on DNA and other cell parts that leads to cancer, heart disease and other diseases of aging. Eating foods that help prevent oxidative damage could enhance health and extend life. So ARS researchers measured the total antioxidant capacity of common fruits, juices and vegetables by an assay known as ORAC—Oxygen Radical Absorbance Capacity. Animal studies on the top-scoring foods are now in progress to see if the ability of these foods to disarm oxygen free radicals in the "test tube" translate to the human body. If so, the advice to eat more fruits and vegetables, particularly berries and greens, takes on added importance. For instance, 3.5 ounces of blueberries—about two-thirds of a cup—had the same antioxidant capacity in the ORAC assay as 1,773 International Units (IU) of vitamin E or 1,270 milligrams (mg) of vitamin C. Blueberries, by far, had the highest antioxidant score of the tested fruits and vegetables purchased in groceries. But scores could vary widely based on growing conditions, season and many other variables in different parts of the country. Concord grape juice had two-thirds the potency of blueberries, and strawberries were about half as potent. Among the vegetables, kale scored a little higher than strawberries, and spinach scored somewhat lower. The ORAC assay is a unique test of total antioxidant capacity in that it measures the degree to which a sample inhibits the action of an oxidizing agent and how long it takes to do so. The researchers are working with equipment manufacturers to develop an instrument for wide application of the assay in analyzing food, blood and other types of samples.

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Chicken drumsticks are giving boron a leg to stand on as an important element for optimum bone growth.

Studies of growing chicks show that boron—found mostly in fruits, vegetables, legumes and nuts—can partially compensate for a low vitamin D intake in bone formation. Like human children, chicks raised on a diet deficient in vitamin D develop rickets, a bone deformity in which the actively growing ends, or growth plates, are weak from lack of minerals. Adding boron to the vitamin D-deficient diet significantly improved the accumulation of minerals in the chicks' growth plates. They added several levels of boron to the chicks' diets to approximate the range people might get through typical diets. After four weeks, they inspected the growth plates under a microscope. Those closest to normal came from chicks getting the highest level of boron—4.2 milligrams per kilogram of feed. This is equivalent to the boron levels in a human diet containing plenty of fruits and vegetables. Even in the chicks raised on diets containing adequate vitamin D, the growth plates tended to mineralize better when the animals got ample boron.

Grand Forks Human Nutrition Research Center,

Grand Forks, ND

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Daily servings of dark green and deep yellow vegetables and tomatoes boost immune response, a preliminary study suggests. If the findings hold up in further research, eating more vegetables rich in beta carotene and related carotenoids—lutein and lycopene—may help people ward off a cold or flu as well as protect against cancer. The researchers wanted to know if people could increase their blood levels of these carotenoids by eating acceptable portions of carotenoid-rich vegetables. So 12 volunteers lunched daily on five servings of cooked kale and sweet potato and washed it down with tomato juice—together providing 10 times more than typical U.S. carotenoid intakes. After three weeks, the volunteers had a 33 percent increase in immune response as measured by the ability of their T cells to multiply. This is a good measure of immune system function because T cells play a vital role in its response to foreign organisms and cancer cells. The veggie lunches also more than doubled blood levels of beta carotene and increased lutein by 67 percent and lycopene by 26 percent. Sweet potato is rich in beta carotene, while kale and tomato are top sources of lutein and lycopene, respectively. As potent antioxidants, these carotenoids are thought to contribute to the lower rates of heart disease, cancer and other diseases of aging among populations that eat a lot of fruits and vegetables. The findings suggest that carotenoid-rich vegetables also stimulate the immune system. But other tests done during the study failed to show any reduction in oxidation of blood lipids or damage to DNA molecules.

Beltsville Human Nutrition Research Center,

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Secrets about the way our bodies absorb and use fats and two essential vitamins might be revealed by experiments with a unique strain of laboratory mice. Researchers with ARS and the University of California at San Francisco have bred mice that don't correctly absorb fats and vitamins A and E that we store in fat. The mice are the first of their kind. While healthy in other ways, they don't form a molecule called apolipoprotein B in their intestines, where it is needed to take up fat. The scientists showed that the mice had slightly low concentrations of vitamin A in their blood and extremely low levels of vitamin E. We require these vitamins for normal eyesight, brain function and health. Further tests using the mice might help researchers determine why some people absorb vitamins A and E much less efficiently than others. Once nutrition and health-care professionals know what factors to look for, they could alert individuals before vitamin deficiencies appear. This information could also enable adjustments in USDA-administered food assistance programs, to ensure that the recipients' needs for vitamin A and E are met.

Western Human Nutrition Research Center, San Francisco, CA

Betty J. Burri, (415) 556-6285

One or two alcoholic drinks a day can interfere with people's B vitamin levels, according to a study of 41 men and women. Blood levels of vitamin B12 dropped when the volunteers consumed five percent of their daily calories as alcohol. Compromising B12 status, over the long term, could impair memory, giving the impression of senility where there's no disease. Most Americans get ample B12 because it is in animal products, including eggs and dairy foods. That's not true for folate which is supplied by dark, leafy green vegetables—such as spinach, broccoli and collards—and citrus fruits and juices. Although folate levels didn't drop with alcohol consumption, they rose significantly during the alcohol-free period. This supports other evidence that the Recommended Dietary Allowance (RDA) for folate is too low because the volunteers were given the RDA in their test diets. Another indicator that moderate alcohol consumption interferes with vitamin B12 and folate was a drop in homocysteine levels during the alcohol-free period. When people don't have enough of these vitamins to metabolize homocysteine, it accumulates in the blood and damages the vessels. Elevated levels of this amino acid have recently been recognized as a risk factor for cardiovascular disease. The findings also help to settle a long-standing debate over the cause of low B

vitamins in alcoholics. Some health professionals argue that it is due to alcoholics' poor nutrition, while other attribute it to the alcohol degrading the vitamins. Both factors appear to contribute.

*Beltsville Human Nutrition Research Center, Beltsville, MD
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Researchers are exploring whether rice starch can be altered to slow its digestion—important news for diabetics who want to keep their blood sugar levels stable as food is broken down in the digestive process. Another potential target audience: marathon athletes who need a steady flow of "fuel" during long periods of exercise. Slow-digesting rice starch is created using enzymes and heat. The altered rice starch also might serve as a fat replacer. It can be made in consistencies ranging from a liquid to a thick cream. This product would provide a new use for broken rice kernels that typically sell for about 7 cents per pound, compared with 24 cents for unbroken kernels, and often wind up in pet foods rather than human food.

*Food and Feed Processing Research, New Orleans, LA
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Teenage mothers don't meet the nutritional needs of their infants through breast feeding alone and rely on formula to supplement. That's what researchers found when they compared the quantity and quality of breast milk and the breast-feeding behavior of 11 teen mothers with 11 adult mothers during the first six months after delivery. Nutritionally speaking, the teens' breast milk was about equivalent to the adults' breast milk in calories, sugar (lactose), fat, protein and the major minerals. But the amount of milk produced by teen moms was one-third to one-half lower than that of the adult moms. Also, the teens did not nurse as long or as often as the adult moms. It's not known whether this behavior is the cause or the result of teens' lower milk production. But the result was that teen moms fed their babies more formula to supplement the lack of breast milk. Education and support aimed at increasing teens' daily nursing duration might improve production and reduce the need for formula, researchers say.

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Rats whose laboratory diets were deficient in copper or magnesium were hyperactive and had either learning or memory deficiencies, suggesting that these two essential minerals may affect human behavior. Researchers tested the psychological impact of each mineral because previous experiments have shown both have important roles in brain function. In one study, they fed rats diets containing either adequate copper or about one-tenth the adequate level for 10 weeks. In a second study,

they altered the magnesium content of the diets in the same manner. Deficiencies of both minerals prompted the rats to be more active in general. That's consistent with symptoms of magnesium deficiency in people who often experience tremors and disrupted sleep. The animals also turned in circles incessantly, similar to people who exhibit obsessive behaviors. The magnesium-deficient rats circled spontaneously, while the copper-deficient did it only after being stressed by a loud noise, the researchers reported. Also, copper-deficient rats were slower to learn, and the magnesium-deficient animals had more difficulty remembering than their counterparts who got adequate doses of these minerals. Magnesium is found in a wide range of plant and animal foods, including nuts, whole grains, green leafy vegetables, meat, fish and poultry and dried fruit. The richest source of copper is oysters.

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Eating more fruits, vegetables and cold cereal fortified with folic acid—a form of folate—should significantly reduce the risk of heart disease and stroke that comes from having high blood levels of homocysteine, a new study shows. These foods contribute the most dietary folate, which the body needs to convert homocysteine into a nontoxic amino acid and thus prevent damage to blood vessels. Researchers found an unusually strong relationship between the amount of these foods consumed and blood levels of folate and homocysteine in a study of 855 elderly men and women participating in the Framingham Heart Study. And that's after adjusting the data for age, gender, total calorie intake and the use of supplements containing folate. Study subjects who ate at least five to six servings of fruits and vegetables daily had the highest blood folate levels and the lowest homocysteine levels, as did those who averaged nearly one serving of breakfast cereal daily. Those who ate less than three servings of fruits and vegetables daily and seldom ate cereal had the highest homocysteine levels, the researchers reported. Orange juice and dark green leafy vegetables, such as broccoli and spinach, were the major contributors of folate among the fruits and vegetables. Women's homocysteine levels were lower than men's. Subjects aged 67 to 80 had lower levels than those over 80, despite higher blood folate levels in the latter group. Supplement users had the lowest homocysteine levels, but not much lower than frequent consumers of fruits, vegetables and cereal. This suggests that people of all ages can reduce their health risk substantially simply by changing their diet. That's especially important for the elderly, who tend to have low folate status.

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Food Safety and Quality

Fuji apples retain flavor and crispness for up to nine months after harvest, thanks to ARS fruit storage methods now used by the apple industry. Previously, Fuji apples were only available to consumers during the fall harvest. No one knew how to keep them fresh for a lengthy market period. However, over six growing seasons, ARS scientists determined how Fuji responds to what's called controlled atmosphere (CA) conditions. CA is a common industry technique used to extend storage life for other varieties of apples by modifying the concentration of the main gases naturally present in air—oxygen, nitrogen, and carbon dioxide. Scientists analyzed the Fuji for changes in color, firmness, starch, sugar and acid content. Results: the best CA treatment for Fuji apples holds storage temperature at 34 degrees F. and maintains oxygen at one to 1.5 percent and carbon dioxide at one percent or less (Fujis are sensitive to this gas). Fuji apple production is rapidly expanding in Washington state. In 1992, growers there produced about 805,000 boxes of Fujis. By 1995, production had jumped to nearly 3.5 million boxes.

Tree Fruit Research Laboratory, Wenatchee, WA
James P. Mattheis, (509) 664-2280

Some people may suffer chronic joint diseases, such as reactive arthritis, after being infected with bacterial food poisoning. ARS research has shown infections from four common foodborne pathogens—*Campylobacter*, *Salmonella*, *Shigella*, or *Yersinia*—can lead to reactive arthritis. A tell-tale sign: In reactive arthritis, the foodborne organisms can't be found in joints, but antigenic components of the infecting bacteria are there. People who have the gene for producing the human leucocyte antigen HLA-B27 are more susceptible to arthritis. While only about 2 percent of people who get food poisoning develop arthritis, about 20 percent of those exposed who carry the HLA-B27 gene get it. This gene is found in about 10 percent of healthy Caucasians, one percent of Japanese, and up to four percent of North American blacks, but is absent from African and Australian blacks. Foods that carry the four common bacteria include raw and undercooked meat, poultry, eggs, shellfish and other seafood, unpasteurized milk, fruit, and vegetables. Untreated drinking water and household pets are also sources.

Microbial Food Safety Research Unit, Eastern Regional Research Center, Wyndmoor, PA
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Harmless yeasts may help thwart toxin-making fungi from infecting pistachios, walnuts and other tree nuts, according to ARS scientists. And, to safeguard people and animals, USDA monitors and sharply limits aflatoxin levels in feed and food products. The principal toxin-making fungi are *Aspergillus flavus* and *A. parasiticus*. They can infect peanuts, grains such as corn, cottonseed, and tree nuts like walnuts and pistachios. Damaged or broken grain kernels or nuts are the most susceptible to fungal attack. In the ARS tests, several strains of *Candida sp.* yeast reduced the number of *A. flavus* spores on artificially infected pistachios by at least 50 percent. The yeasts out-compete the fungi for nutrients, and produce chemicals that inhibit fungal growth. Yeasts are good candidates for biological control, because they are easy to grow and can live a long time on dry surfaces such as nutshells without harming the nut itself. Next, scientists will conduct larger tests on several types of nuts. They're also experimenting with best methods for applying the yeasts to nuts.

Plant Protection Research Unit, Albany, CA
Sui-Sheng Hua, (510) 559-5905

Hot summer days can mean better bread for consumers. Researchers discovered that hard red wheat exposed to the right number of 90-degree-plus days makes a better loaf of bread. Armed with this information, commercial millers and bakers might shop for wheat grown in areas with just the right amount of sun-baked weather. But it is possible to get too much of a good thing: Too many high-heat days can cause a breakdown of the gluten protein structure in the wheat kernel, resulting in poor-quality flour and lower-quality bread. Gluten protein imparts to wheat its unique ability to function in leavened bakery products.

Wheat, Sorghum and Forage Research, Lincoln, NE
Bob Graybosch, (402) 472-1563

Consumers, confectioners and fruit growers could benefit from novel fruit products developed by ARS scientists. In experiments, researchers made molded, restructured fruit pieces containing up to 30 percent apricot or peach puree. Another method, twin-screw extrusion, produced licorice-like ropes containing up to 100 percent fruit. Many commercial snacks containing fruit include much more sugar than these pieces and use less than five percent juice or puree. The higher fruit content of the ARS products could make them a healthier addition to confections and baked goods. Restructured fruit products could also expand the market for soft fruits that can be pureed during the growing season and used by manufacturers year-round. New combinations of starch and gelatin allow the puree to be custom-manufactured into a wide range of products.

*Process Chemistry and Engineering Research, Albany, CA
Tara McHugh, (510) 559-5864*

Whole-wheat bread made from hard white wheat may become more appealing to American consumers. That's because researchers are working to breed white wheat that contains less amylose starch. Reducing amylose boosts palatability of bread and may extend its shelf life. Hard white wheat also could give American wheat growers a better shot at the burgeoning Oriental noodle market here and abroad. Asians prefer white wheat's lighter color and chewier mouth feel. Researchers are looking for ways to grow hard white wheat varieties with just the right qualities to make Oriental noodles and some types of low-cholesterol whole wheat breads.

*Wheat, Sorghum and Forage Research, Lincoln, NE
Jim Peterson, (402) 472-5191*

Maintaining and improving the quality of fresh-cut produce is a major challenge in the fast-growing market for fresh fruits and vegetables. A chlorine solution now used by industry to control microorganism growth isn't always effective. In a joint study with Japanese scientists, ARS researchers reduced microorganism growth on cut carrots without altering firmness by dipping the carrots in a calcium chloride solution. The calcium chloride treatment also worked well on zucchini squash, which is highly perishable and very sensitive to cold temperatures. The ARS study also showed fresh-cut produce should be handled and stored at or near 32 degrees F if the product is not sensitive to chilling injury. Many processors prepare, ship and store fresh-cuts at 41 degrees or even 50 degrees F. Sales of fresh-cut produce in the United States are projected to increase from \$5.8 billion in 1994 to \$19 billion in 1999.

Horticultural Crops Quality Laboratory, Beltsville, MD

Alley E. Watada, (301) 504-6128

IPM/Biological Control

USDA researchers are looking to sabotage the love life of gypsy moths by "seeding" the tree canopy where they mate with tiny pheromone dispensers. Scientists want to disrupt mating to prevent caterpillar offspring, which are responsible for defoliating trees. The air-dropped dispensers are little more than soft plastic beads or flakes less than three millimeters in size. They are sprayed by plane as an insecticide-free defense against isolated or low-level gypsy moth infestations. Held to tree leaves by a glue-like substance—or sticker—they saturate the surrounding air with a synthetic version of the female moth's chemical sex attractant or pheromone. This thwarts the males'

ability to home-in on the real chemical beacon from females. In the researchers' studies, the pheromone applications prevented nearly 100 percent of the moths from mating. As a result, the number of fertile egg masses on pheromone-protected trees was cut by 75 to 100 percent compared to trees in untreated plots. Scientists are studying various ways to distribute the dispensers for maximum effectiveness and ease of application from spray aircraft.

*Insect Biocontrol Laboratory, Beltsville, MD
Kevin Thorpe, (301) 504-5689*

Two of six new species of insects are candidates for biological control of paperbark, a large tree that has become the most troublesome terrestrial weed in the United States. Introduced into Florida in 1906 from Australia as an ornamental, paperbark (*Melaleuca quinquenervia*) now invades over 500,000 acres and causes extensive environmental and economic damage. Conventional control measures, like cutting, burning and herbicides, are costly, ineffective and environmentally inappropriate in managing this pest. ARS scientists have for the first time identified several gall midges (*Lasioptera* and *Lophodiplosis*) that are native to Australia that may suppress the growth of this tree. Several have been identified as being potential biocontrols because they are highly specific in attacking paperbark buds and leaves and in keeping it under control. Six of these insects are species new to science and are named and described in detail. Researchers trying to find natural control for this tree pest will now be able to readily identify and distinguish among these exotic insect species. Biocontrol specialists can now begin research to introduce them into Florida.

Systematic Entomology Laboratory, National Museum of Natural History, Washington, D.C.

Raymond J. Gagne/ Joseph K. Balcunas, (202) 382-1796/(510)559-5841

They're not quite insects and not quite worms—they're velvetworms, a true scientific oddity in an ongoing exhibit at the Smithsonian's Insect Zoo in Washington, D.C. Referred to by scientists as *Onychophora*, velvetworms look much like slugs with legs. Their cylindrical bodies are covered with growths called tubercles that give them a velvety appearance. Velvetworms can grow up to 6 inches long, with as many as 43 pairs of legs, depending on the species and sex. The creature's head sports antennae and two cone-shaped structures that squirt an adhesive material to help snare prey. Discovered in 1825, velvetworms live under logs, stones or leaves in tropical rain forests. ARS scientists collected five males and one pregnant female in Costa Rica. The female has given birth to several young that are being carefully tended at the Insect Zoo in the Smithsonian's Natural History Museum. The velvetworm exhibit is aimed at educating the public about insects and

their relatives, as well as providing more knowledge about their behavior.

Systematic Entomology Laboratory, National Museum of Natural History, Washington, DC
Dave Adamski, (202) 382-1778

A little worm with a big name—*Psammomermis nitiduesis* n.sp.—could be bad news for crop-damaging sap beetles. Scientists discovered the new nematode species among beetles found near sweet corn fields in two Illinois counties. Up to 80 percent of sap beetles collected in the spring were killed by *P. nitiduesis*. The nematode uses the sap beetles to reproduce. Sap beetles burrow into sweetcorn ears at the critical milk stage, rendering them unacceptable to consumers. The beetles also spread *Fusarium* and *Aspergillus*, fungi that produce toxins harmful to humans and animals. Effective biological controls against the beetles have been difficult to establish. Scientists are studying ways to distribute *P. nitiduesis* and pit it against the sap beetle throughout the Corn Belt.

Mycotoxin Research, Peoria, IL
Patrick Dowd, (309) 681-6242

Crop Productivity

A smoothroot sugarbeet could help growers lighten their load at harvest and still collect more profits. The grooved taproot of conventional sugarbeets is an ideal place for soil to cling. Growers and processors must treat harvested sugarbeets roughly to remove this excess soil. This usually results in bruising, which lowers the beets' sugar content and encourages spoilage in storage. Also, processors must deal with excess soil from the roots as waste. A smoother sugarbeet taproot means less soil clings to the beet when it's pulled from the ground—and less damage to the beet in soil removal efforts. In tests, the harvested smoothroot sugarbeet carried along 70 percent less clinging soil than conventional sugarbeets. Sugarbeets are a million-dollar industry, with production concentrated primarily in California, Idaho, Michigan, Minnesota, Montana, Nebraska, North Dakota and Wyoming.

Sugarbeet and Bean Research Laboratory, East Lansing, MI
Joe Saunders, (517) 355-9280

A quirk of nature may someday provide an inexpensive biofuel or improve the production of man-made fertilizers. Some soil microorganisms use enzymes that contain iron or iron and vanadium, elements naturally present in the soil, to convert nitrogen in the atmosphere into a form plants can use for growth. Hydrogen that's produced in the nitrogen-conversion process—but not used by the plants—could be collected and put to work as a biofuel, scientists say. Another plus: Bacteria that

use iron in this process could provide clues as to how iron might serve as a catalyst in making nitrogen fertilizers. Current ammonium fertilizer production uses extremely high temperatures and pressure, a process that requires lots of fossil fuel. An alternative process could lower costs and preserve fuel.

Soybean and Nitrogen Conservation Laboratory, Raleigh, NC
Paul Bishop, (919) 515-3770

Kanza is a new pecan variety that produces high-quality nuts ready for sale at premium prices before other varieties can reach the market. Next year, growers nationwide as far north as Kansas will begin planting Kanza, developed by researchers with ARS and state experiment stations in Kansas, Oklahoma and Texas. Kanza pecans could be ready for harvest as early as September 10 in southern Texas and by late September in Kansas. Other early-season cultivars could be used to pollinate hybrid nuts from Kanza, as it is the first pecan developed since 1976 that produces receptive female flowers before it produces pollen from male flowers. The tree is cold-tolerant and will require less pesticide to control diseases such as scab, fungal leaf scorch, and leaf and stem phylloxera. In 1995, approximately 268 million pounds of pecans were produced nationally with a value of about \$272 million.

Crop Germplasm Research, College Station, TX
Tommy E. Thompson, (409) 272-1402

A new pecan variety called "Creek" can produce marketable nuts within five years after planting, giving growers in Southeastern states up to two years' head start on profits. Developed by researchers with ARS and the state experiment stations of Alabama, Georgia, Louisiana and Texas, Creek has an important environmentally-friendly trait: natural resistance to a common fungal disease called scab. Nuts produced by Creek are large enough to be sold in shell or shelled to produce attractive kernel halves. Pecans are a multimillion-dollar industry that provides income for rural landowners with orchards or woodlands pasture.

Crop Germplasm Research, College Station, TX
Tommy E. Thompson, (409) 272-1402

Farmers who plant winter wheat in rotation with sunflowers could reap about 12 bushels more wheat per acre on the Central Great Plains. ARS researchers say the key is to leave 2-foot high sunflower stalks standing after harvest rather than chopping them down to the ground level. The taller stalks help trap drifting snow, reduce wind erosion, and slow the evaporation of moisture in the soil. This results in soil trapping up to 3 more inches of moisture for the wheat. Then, after an 11-month fallow period, farmers should use minimum tillage to seed winter wheat through the sunflower plant residue. Winter wheat plants sprout and grow in the

fall, go dormant during winter and resume growing in spring. After the wheat is harvested in July, its stubble protects soil for 11 months just like the sunflower stalks did. Sunflowers are then planted the following June for harvest that October. Scientists say such a practice results in farmers getting 2 crops every 3 years versus one wheat crop every other year produced in the traditional wheat-fallow system.

*Central Great Plains Research Station, Akron, CO
David C. Nielsen, (970) 345-2259*

Growers of Austrian winter peas can now obtain a new ARS-developed variety that outperforms current varieties of this soil-boosting "green manure" crop. Though a close relative of snap peas, Austrian winter peas are generally not grown as a food commodity because the seed coats contain unappealing pigments. In the United States, most winter peas are grown in the Southeast. Farmers plant the crop in the fall and plow under the nitrogen-rich plants in the spring to supply nitrogen and other nutrients for peanuts, cotton and other summer crops. Most of the seed supplies are grown in the Pacific Northwest. Some seed is exported to Asia for use as pigeon feed or a confectionary paste known as "an" (pronounced "on"). The new variety, named Granger, has a unique growth habit that helps the plant resist disease. That's why the new variety yields about 20 percent more seeds than other Austrian winter peas. Typical winter pea plants have two to three sets of leaflets along the stem. As leaves and pods grow heavy, they pull the vines to the ground. Mold and fungal diseases thrive in the resulting moist mat. But Granger has few or no leaves. Instead, the plant sends out extra tendrils. These wind around neighboring plants, creating a 5-foot-tall plant "wall" that keeps Granger dry and off the ground, safer from the disease organisms.

*Legume Genetics and Physiology Research Unit,
Pullman, WA
Frederick J. Muehlbauer, (509) 335-9521*

Two new ryegrass lines may bring scientists closer to understanding how grasses develop genetic resistance to weed-killing chemicals. The new lines have high tolerance to diclofop-methyl, known in the United States by the trade name Hoelon. This herbicide is registered to control grass weeds in broadleaf and cereal crops. In western Oregon, ryegrass is not only a major turf and forage crop but also one of the worst weeds of winter wheat. Weedy wheat fields can produce 40 to 50 percent less grain than uninfested fields. The grass weeds can become almost completely resistant to diclofop in as little as three years. Understanding the biological mechanism of resistance would help scientists develop better controls for this and other grass weeds. The ARS scientists have already showed that ryegrass' chemical resistance is controlled by only one or two genes. Studying how resistance developed has been difficult because research-

ers have lacked populations of resistant and susceptible plants that were otherwise identical. Researchers can now make comparisons using the new lines. ARS scientists developed them from selections from Gulf and Marshall ryegrass varieties. Small quantities of seed of the new lines, ORARHR-G93 and ORARHR-M93, are available to researchers.

*National Forage Seed Production Research Center,
Corvallis, OR
Reed E. Barker, (541) 750-8722*

A greenhouse-sized fungus attack is helping researchers understand what happens when *Aspergillus flavus* fungi strike in cotton fields. Conditions in the greenhouse are kept warm and dry—the type of environment favored by *A. flavus*, which produces a potent toxin called aflatoxin. Aflatoxin doesn't affect cotton quality or fiber safety. But cottonseed—a valuable product of the cotton crop—can't be used in food or feed if it contains more than 20 parts per billion of aflatoxin. Researchers hope to uncover contributing factors behind *A. flavus* outbreaks, such as wind.

*Food and Feed Safety Research, New Orleans, LA
Maren Klich, (504) 286-4361*

Growing broccoli in a new, no-till system of soybean mulch cuts chemical use, eliminates soil erosion and conserves water while maintaining yields. ARS scientists grew a high-nitrogen forage soybean variety to a height of about 5 feet. Then they cut or flattened the plants to form a mulch to cover the soil before planting broccoli seedlings. The thick thatch keeps down weeds and holds moisture while enriching the soil with organic matter and protecting it from erosion. Under this new system, more broccoli could be grown in the mid-Atlantic states of Pennsylvania, Maryland, West Virginia, Virginia and North Carolina where soils are highly erodible and the terrain is sharply sloped. In California, where about 88 percent of U.S. broccoli is grown, the crop is directly seeded in bare soil and requires two to three chemical treatments to kill weeds, the major cause of broccoli crop losses. Per capita consumption of broccoli in the United States in 1996 reached almost 6 pounds, in contrast to about 1.5 pounds in 1970. Broccoli is high in vitamins and dietary fiber and rich in sulforaphane, a compound associated with reduced risk of breast cancer. Researchers at Virginia Polytechnic Institute and State University in Blacksburg, VA, collaborated with ARS on the soybean mulch-broccoli studies.

*Vegetable Laboratory, Beltsville, MD
Aref A. Abdul-Baki, (301) 504-5057
Weed Science Laboratory, Beltsville, MD
John R. Teasdale, (301) 504-5504*

A simple new field test tells Louisiana sugarcane producers within six hours whether their crop is

infested with leaf scald bacterium—even when the crop shows no symptoms. The test costs about \$2. It uses a diagnostic technique called polymerase chain reaction (PCR) to identify bacteria on plant leaves by telltale bits of DNA. The test has been adopted by Louisiana State University in Baton Rouge.

Sugarcane Research, Houma, LA

Yong Bao Pan, (504) 872-5042

The same kinds of natural proteins that regulate human hormone secretion and blood vessel constriction also have a hand in determining how much nitrogen fertilizer crops can use, ARS researchers have discovered. These proteins, called 14.3.3 proteins, represent an important on-off switch in plants. Plants contain an enzyme called nitrate reductase. This enzyme can turn fertilizer's nitrate into nitrite. During daylight hours, the plant uses the sun's energy to convert the nitrite into amino acids the plant needs for survival. But at night, without the energy source, the nitrite can accumulate in the plant and kill it. The 14.3.3 proteins play a role in shutting down the plant's nitrate-to-nitrite conversion activities at night. If researchers can find a way to manipulate this natural process, they could alter plant metabolism to boost crop yields on nutrient-poor soil.

Plant Science Research Unit, Raleigh, NC

Steve Huber, (919) 515-3906

Crop Diseases and Pests

Some species of thrips are insect pests of flowers, ornamentals and agricultural crops. But few are beneficial as predators of mites and insects and as pollinators of crops. University of Florida and ARS scientists showed for the first time how thrips pollinate West Indies mahogany tree flowers in Florida. These hardwood trees from the tropics are grown for their valuable wood. They also are favored ornamentals along roadsides. ARS research identified five species of thrips that were the only insects found in 12 to 59 percent of mahogany tree flowers collected from seven sites located many miles apart. Pollen coated their bodies, providing the first evidence that some thrips help cross pollinate mahogany trees. Further studies are needed to find out how effective these insects are as pollinators over the long run. Since little was known previously about pollination of this valuable tree, this information increases understanding of how mahogany trees are pollinated and could be used by scientists worldwide who work on breeding better mahogany trees.

Systematic Entomology Laboratory, Beltsville, MD

Sueo Nakahara, (301) 504-6893

A search for genes that enable a corn plant to "starve" leaf-eating fall armyworms has been narrowed by ARS and Mississippi State University scientists. Their ultimate goal is to genetically engineer commercially available corn hybrids so they too can have this built-in pest protection. Recently, the scientists determined that the gene they seek is

Mir1, responsible for making the protein 33 kD cysteine proteinase. When hungry armyworms munch corn leaves and ingest the protein, they may stop growing or starve. The scientists hope to insert the protein-making gene into susceptible corn hybrids or other crops that are targets of hungry armyworms and other destructive caterpillar pests. The researchers isolated Mir1 from the tissue of a worm-resistant corn line, Mp 708. They then made millions of copies of the Mir1 segment. This helped them identify nearly all the nucleotides—or individual chemical constituents—comprising Mir1. The scientists then inserted the Mir1 segment into bacteria for use as microbial workhorses in studies of the protein's effectiveness. Besides armyworms that attack corn, the genes may someday quell the appetite of other lepidopteran pests of other crops.

*Corn Host Plant Resistance Research Unit,
Mississippi State, MS*

W. Paul Williams, (601) 324-2735

Romance could turn deadly for amorous pecan weevils. ARS and Oklahoma State University scientists—for the first time—have identified the weevil's chemical sex attractant, or pheromone. This could lead to a commercial pheromone that pecan growers could deploy to monitor weevil populations or to disrupt weevil mating. Prospective mates either couldn't find each other or would be lured to doom in traps. In lab and field studies, a synthetic version of the male weevil's pheromone attracted 80 percent of females. Chemical insecticide sprays are now the main recourse for protecting pecan orchards. Unchecked, the weevils chew on young pecan nuts, ruining their marketability. In late summer, female weevils bore into nuts to lay eggs. Soon, larvae hatch, drop to the ground and burrow into the soil. Two to three years later they emerge as adults and start the cycle over again. University scientists are awaiting results of large-scale field tests of the synthetic attractant in orchards this past summer. ARS is considering patenting the use of the weevil pheromone.

Crop Science Research Laboratory, Mississippi State, MS

Paul Hedin, (601) 323-2230

"Squash 'em!"—but not literally. That's the advice of ARS scientists who showed that squash plants will lure cucumber beetles and squash bugs away from more valuable crops like watermelon and cantaloupe. The tactic could be a new way to reduce insecticide sprays on the melons. Since squash is the insects' favorite cucurbit, they will feed on it first. In spring, growers typically spray plant seedlings with insecticide two to three times. But they could use less insecticide by planting one or

two rows of squash as a "trap crop" around the field's perimeter. In experimental watermelon and cantaloupe plots, the tactic lured up to 66 percent of a plot's total population of the insects. The attraction was fatal for 90 percent of them, because the scientists sprayed insecticide only on the squash perimeter of a plot. Commercial growers in Texas and Oklahoma are helping the scientists run large-scale field studies. In the Midwest, the approach could also help stop cucumber beetles from spreading a bacterial disease, cucurbit wilt, through the melon patch.

*Southcentral Agricultural Research Lab, Lane, OK
Sam D. Pair, (405) 889-7395*

Four new ARS corn germplasm lines could eventually supply corn farmers with new varieties that curb the appetite of harmful, worm-like organisms called nematodes. ARS scientists developed, tested and have released the new corn lines to plant breeders and other researchers. The lines are Mp 709, Mp 710, Mp 711 and Mp 712. Each withstands the southern root knot nematode, *Meloidogyne incognita*, and peanut root knot nematode, *Meloidogyne arenaria*. Both pests are prevalent in the southeastern United States and primarily infest sandy soils where they tap vital nutrients from corn plant roots. This can cause yield losses of up to 30 percent. The new resistant corn plants squelch such feeding, though scientists don't yet know how. In greenhouse tests, the scientists applied 3,000 nematode eggs to seedlings of both the resistant lines and a susceptible check called Ab24E. After 60 days, they counted the eggs that remained. Using a rating index of 0 (for no egg masses) to 5 (for more than 100 eggs masses per plant), they found Mp 709 was most resistant, rating 0.1. Second best was Mp 710, at 0.9. The susceptible check earned a 3.5 rating. Scientists say the lines' yield and other agronomic traits can be improved through cross breeding with commercial corn.

*Crop Science Research Laboratory, Mississippi State, MS
W. Paul Williams/Gary L. Windham, (601) 323-2735/2230*

Two plastic mulches are controlling nutsedge, one of the 10 most common and troublesome weeds in Florida vegetable crops. Few chemicals other than methyl bromide—which has been identified as an ozone depletor and is slated to be banned in 2001—are available to control nutsedge. In both greenhouse and field experiments, ARS scientists significantly suppressed purple nutsedge by using photoselective infrared transmitting mulch films and silver mulch films. More research is planned on how these mulches work to suppress the weeds.

*U.S. Horticultural Research Laboratory, Fort Pierce, FL
David T. Patterson, (407) 467-3081*

Researchers are genetically altering tomato plants to resist attacks by microscopic worms called nema-

todes. Tomato growers now use methyl bromide to rid the soil of nematodes and other harmful organisms. But methyl bromide—probably the most widely used pesticide in the world—has been identified as an ozone depletor and is scheduled to be banned in 2001. Several tomato genes play a role in providing nematode feeding sites. Researchers have linked these genes to a genetic switch that is turned on when nematodes start to feed. Tomato plant cells that now serve as feeding sites for root knot and reniform nematodes will malfunction, eliminating the pest's food source. The ultimate goal: Tomato plants that will produce more and larger fruit without using methyl bromide.

*U.S. Horticultural Research Laboratory, Orlando, FL
David T. Kaplan, (407) 897-7300*

Tomatoes infected with a newly described virus, tomato chlorosis, should now be easier to diagnose. ARS virologists developed a test that determines within 24 hours whether a plant has the virus. It's transmitted by four species of sap-sucking whiteflies, major pests of tomatoes and other crops. The University of Florida's plant disease clinic in Gainesville is now using the ARS test on leaf specimens sent by growers. Florida produces more than a third of the nation's \$460 million tomato crop. The clinic's researchers will also use the new test to identify weed species that are vulnerable to the virus. Whiteflies may be carrying virus from those weeds to nearby tomato fields. The test relies on molecules, called nucleic acid probes, that detect the virus' genetic material. These are the first such probes for this virus. ARS scientists and their clinic colleagues were the first to describe and name the tomato chlorosis virus. It causes leaves to yellow and thicken, and plants to produce fewer and smaller fruit. The ARS tests indicate that greenhouse, banded-wing, sweetpotato and silverleaf whiteflies all can transmit the virus.

*U.S. Agricultural Research Station, Salinas, CA
James E. Duffus/Gail C. Wisler, (408) 755-2835*

ARS scientists have tentatively classified a bacterium that's helping control the citrus root weevil in Florida citrus groves. The weevil, which can cost citrus growers more than \$1,200 per acre, has already caused an estimated \$72 million loss to Florida's economy this year. The beneficial bacterium is produced by microscopic worms called *Steinernema riobravo*s nematodes. Preliminary tests indicate the bacterium may belong to the genus *Xenorhabdus*. The *S. riobravo*s nematodes are sprayed onto the soil and burrow down to tree roots, where they find and parasitize citrus root weevil larvae. Once inside the larvae, the nematodes release the bacteria, killing the larvae within 48 hours. The nematodes reproduce inside the larvae and the offspring are nourished by the bacteria, which also release antimicrobial agents that prevent the growth of other bacteria, eliminating competition. Scientists are investigating

other natural "carriers" that might develop a similar symbiotic relationship with the bacterium and thus become another potential biological control agent for the citrus root weevil, which has also become a significant threat to ornamental and vegetable crops.

*U.S. Horticultural Research Laboratory, Orlando, FL
William J. Schroeder/Heather Smith, (407) 897-7300*

A new ARS-developed peach rootstock could offer an alternative to using the pesticide methyl bromide to rid the soil of nematodes that cause peach tree short life (PTSL). PTSL is a major problem for peach growers throughout the southeastern United States. Scientists with USDA's Agricultural Research Service developed the new rootstock—in conjunction with Clemson University researchers—to resist the ring nematode that leads to PTSL-related tree death. ARS scientists have recently found that this rootstock also resists the root-knot nematode, which causes reduced tree growth of young trees. Called Guardian™, the new rootstock is now available at commercial nurseries as bulk seed for next year's growing season.

*Southeastern Fruit & Tree Nut Research Lab, Byron, GA
Andy P. Nyczepir, (912) 956-5656*

A new technique cuts out the need for an insect "middle man" to transmit insect transmitted plant viruses. Insects traditionally have been used as vectors to transmit viruses to plants, a method requiring special skills to rear and manipulate an insect population. Researchers have shown they can transmit all major insect-obligate corn viruses by using insect pins. The pins are pushed through a drop of virus into the vascular system of the corn seed which has been soaked in water. Transmission rates in plants from inoculated seeds are similar to the rates achieved using insects as vectors. The new method will help reduce research delays and disruptions caused by using insects and make it easier to evaluate for virus resistance in corn worldwide.

*Corn and Soybean Research, Wooster, OH
Ray Louie, (330) 263-3836*

Wheat breeders who think they're closing the door on one type of leaf rust problem may be opening the door to another. In their attempts to develop wheats with resistance to *Puccinia triticina*, the leaf rust that attacks wheat, breeders have "borrowed" genes from rye and wild grasses related to rye. Previously, wheat leaf rust and rye leaf rust were thought to be caused by the same fungus, *Puccinia recondita*. Now ARS scientists have shown that rye leaf rust and wheat rust are caused by two distinct fungus species, *P. triticina* which attacks wheat and *P. recondita*, that attacks rye. By transferring genetic material from rye or a wild rye relative to wheat, the breeders could be creating new wheat varieties which are susceptible to *P. recondita* and *P. triticina* both types of rusts. In addition, triticale, a hybrid of wheat and rye

may be vulnerable to both types of leaf rust.

*Cereal Rust Laboratory, St. Paul, MN
Kurt Leonard, (612) 625-5786*

Estragole, a natural chemical found in leaf oil in some varieties of avocado, kills the Caribbean fruit fly. ARS scientists first discovered and reported that the compound is toxic to insects. They've found it in varying concentrations in the leaves of 14 varieties of Mexican avocados—but none in the seven Guatemalan and 13 West Indian types of avocados tested. Further research is needed to genetically manipulate the gene responsible for producing estragole to give plants natural resistance to the Caribbean fruit fly and possibly other insect pests. Malathion is now used to control this fruit fly, but environmental and health concerns have been raised about the chemical. Scientists and industry are looking for a replacement.

*Subtropical Horticulture Research Lab, Miami, FL
Jimmie R. King, (305) 238-9321*

Leaf hairs on the surface of wheat plants may protect the crop against fungal infection. ARS scientists used a scanning electron microscope to demonstrate that wheat plants with greater leaf pubescence—hair-like structures on the leaf surface—are less susceptible to fungal infection. When a fungal spore lands on a leaf surface, it sends out a germ tube or "root" to penetrate the stomate—a small pore in the leaf surface—that enables the plant to exchange carbon dioxide and oxygen. If plant surfaces are covered with leaf hairs, the spores become entangled in the maze of hairs and die before they can penetrate the stomate. Scientists say wheat plants might be bred to have more leaf hair, deterring fungal infection.

*Cereal Rust Research Unit, St. Paul, MN
Dave Long, (612) 625-1284*

A fungus-killing compound from oats could be the key to stopping the water-borne mold *Aphanomyces* from inflicting millions of dollars of damage on the edible pea crop every year. Researchers have isolated the compound, called avenacin. It's produced by the living oat plant but becomes toxic to the fungus when the plant is injured, such as by being tilled under, and stays in the soil even after the oat plant dies. Saratin kills spores of *Aphanomyces* before they can complete the fertilization process. For effective biocontrol, scientists recommend pea growers plant oats in a rotation and till in the stalks after harvest, or as a second crop in the fall, then chisel-plow the green crop into the ground. A new crop of peas planted on the same ground the following spring would reap the benefits of avenacin. Another plus: Oats used as a biocontrol for the fungus also encourage soil-saving conservation tillage, as avenacin must remain in the top 4 inches of soil to be effective. Research shows mold-board plowing and traffic-induced soil compaction

contribute to the spread of *Aphanomyces*.

Soil and Water Management Research, St. Paul, MN
Ray Allmaras, (612) 625-1742

Animal Productivity

Steers prefer two crested wheatgrass varieties over six other wheatgrass and wildrye cultivars, ARS researchers have found. Knowing which plants animals like most will help beef producers plan how to reclaim pastures and revegetate range. To determine forage preferences, scientists recorded each bite taken by three randomly selected steers in test grazing areas. All the tested grasses provide adequate nutrition, but CD-II was the animals' clear favorite, followed by Nordan. Goldar bluebunch wheatgrass, Bannock and Secar thickspike wheatgrasses, Bozoisky Russian wildrye and Magnar and Trailhead basin wildrye were also tested. CD-II, formerly called Hycrest II, was developed by ARS plant breeders at the Forage and Range Research Unit in Logan, Utah. The animals were choosiest when the grasses were young and green, picking CD-II one-third of the time. They were less selective among mature forage. Stand of CD-II and Nordan were also easier to establish and out-competed surrounding plants and weeds. This makes both varieties good candidates for pasture revegetation in arid grasslands.

Eastern Oregon Agricultural Research Center, Burns, OR
David Ganskopp, (541) 573-2064

The traditional feedlot has become a laboratory for scientists who study animal behavior. Scientists are using a specially equipped mobile lab at a feedlot in Lubbock, Texas, to keep an eye on problems such as buller-steer syndrome. The bullied animal often loses weight and may suffer other stress-related health problems. Buller-steer syndrome costs feedlot operators an estimated \$3.5 million annually. The mobile laboratory is a converted recreational vehicle fitted with four video cameras, and night-vision goggles developed for the military. These high-tech tools allow researchers to monitor cattle at night without artificial light. Scientists say the extended surveillance will help them determine what triggers buller-steer syndrome and whether it can be prevented or reduced.

Livestock Behavior Research Unit, West Lafayette, IN
Julie Morrow-Tesch, (317) 494-8022

Animal Diseases and Pests

A new vaccine headed for market protects cattle against the pneumonia-causing bacterium *Pasteurella haemolytica*. Pneumonia caused by this bacterium costs U.S. and Canadian cattle growers more than \$1 billion

annually. At the heart of the new vaccine is the world's first genetically engineered strain of *P. haemolytica*, produced by ARS researchers. The new vaccine could be marketed next year. Meanwhile, the researchers have already tackled their next task: a single vaccine that protects against the bad-news bacterial trio—*P. haemolytica*, *P. multocida* and *Haemophilus somnus*. (PATENT APPLICATION 08/162392)

National Animal Disease Center, Ames, IA
Robert E. Briggs/Fred M. Tatum, (515) 239-8280

The problem: Parasites called coccidia commandeer the very cells that a chicken's immune system produces to kill them, leaving the bird defenseless against this \$600-million-a-year disease. The solution: A specially developed chicken monoclonal antibody that blocks the parasite's ability to attach to and ultimately invade the defensive cells, called cytotoxic T-cells. Researchers also are investigating the use of cytokines—substances produced naturally by the chicken's white blood cells—as a weapon against coccidia. Laboratory tests show some cytokines inhibit development of coccidia parasites in the bird. They also turn precursor cytotoxic cells into active cytotoxic cells that hunt down and kill parasite-infected host cells. Cytokines rally white blood cells called macrophages to devour and destroy the parasites. Unfortunately, coccidia thwart pharmaceutical treatments by rapidly developing resistance to the drugs used against them.

Immunology and Disease Resistance Laboratory, Beltsville, MD
Hyun S. Lillehoj, (301) 504-8771

Neutrophils—a type of white blood cell—go into action against dairy cows' mastitis infections when they get the signal from a naturally produced protein. The protein was isolated and purified in studies in 1994-95 by scientists with ARS and the Institut National de la Recherches Agronomique, Nouzilly, France. The next step: Pinpointing how the protein directs neutrophils into the mammary gland and how much protein is needed for an effective neutrophil response. Mastitis, an infection of the cows' udder, costs U.S. dairy farmers \$2 billion annually in treatment and lost milk production. When a cow's udder becomes infected, neutrophils rush to attack the invading bacteria. Until now, researchers had little information on what triggered the neutrophils' charge. The protein might someday be used in cows to protect against mastitis-causing bacteria.

Immunology and Disease Resistance Laboratory, Beltsville, MD
Max J. Paape, (301) 504-8302

Soil, Water and Air Quality

An alfalfa variety that takes its nitrogen from the soil rather than the atmosphere could help environmental engineers know when soil is no longer chemically contaminated. Researchers developed "ineffective" alfalfa for use as a high-nitrogen forage and a type of biological chemical detector. Typically, alfalfa takes nitrogen from the atmosphere and transforms it into a form the plant can use for growth. By contrast, ineffective alfalfa receives all its nitrogen from the soil. When nitrogen levels in the soil are low or depleted, ineffective alfalfa turns yellow. Scientists are studying the use of ineffective alfalfa on chemical spill sites as a scrubbing agent to draw contaminants out of the soil and as a biological indicator that the site is clean. The alfalfa can also be used as high-quality animal feed.

Plant Science Research, St. Paul, MN
Carroll Vance, (612) 625-5715

Grasses and sedges clipped short are as effective as taller stubble vegetation in trapping sediment being washed into streams. Researchers say the key is the width of the grass barrier, not stubble height. A grass barrier 30 feet wide will reduce sediments in overland runoff by 98%, according to results from a cooperative 2-year study by ARS and Colorado State University. The scientists used a large rotating irrigation boom to simulate rainfall over two test sites along Sheep Creek in northern Colorado's Roosevelt National Forest. They discovered stubble as short as one inch could slow water flow and trap sediment as effectively as stubble up to six inches tall. That's important news for land management agencies seeking information on how to rehabilitate overused areas—such as areas damaged by recreation or livestock grazing along rivers and streams.

Crops Research Laboratory, Fort Collins, CO
Gary W. Frasier, (970) 498-4232,
gfrasier@lamar.colostate.edu

Rising carbon dioxide levels in the atmosphere could prompt a future adjustment in fertilizer recommendations for soybean and other crops. A study of grain sorghum and soybean shows that a carbon boost may enable plants to yield more on less nitrogen. But it also can make soybeans appear nitrogen deficient by a standard leaf test. Researchers grew the crops in air containing twice the current CO₂ concentration—now about 360 parts per million—because CO₂ levels are expected to double during the next century if they continue increasing at the current rate. Soybean leaf nitrogen fell below a critical threshold that, by today's standards, should have caused at least a 10-percent drop in yield. Instead, yield was up 35 percent without any additional fertilizer. That's because the increase in plant growth and leaf size caused by additional CO₂ diluted

nitrogen levels. Sorghum yields were up 18 percent, not enough to affect the nitrogen level in the plants. If yields of soybeans, sorghum and other major crops go up in step with CO₂ levels over the next century, scientists will have to alter the estimated critical nitrogen threshold for maximum yields.

Soil Dynamics Research Laboratory, Auburn, AL
D. Wayne Reeves, (334) 844-4741 Ext.138

Tropic Sun, a variety of sunn hemp, is a super cover crop that grows to its full 6-foot height in 10 weeks, compared to seven months for other crop rivals such as hairy vetch and crimson clover. Tests show that sunn hemp, *Crotalaria juncea*—not to be confused with hemp, or marijuana, *Cannabis sativa*—can be planted in the southern United States immediately following a corn harvest, quickly providing almost total ground protection against fall and winter rains. It takes seven months for other cover crops such as hairy vetch and crimson clover to provide similar protection. Tropic Sun hemp also has proven useful as a forage for livestock, providing high levels of protein in its leaves when other pastures are normally in a "lull." And, applied at 120 pounds per acre, it makes as much nitrogen as slower growing legume cover crops. That leaves some for next year's corn crop but also increases the possibility of nitrogen losses to groundwater over the winter. Scientists are trying to work winter wheat into the corn-hemp rotation to use up the excess nitrogen, perhaps giving wheat a free ride, with no additional fertilizer. USDA's Natural Resources Conservation Service released Tropic Sun seed for potential development as a green manure/cover crop variety. The sunn hemp it was bred from has been used for centuries as a green manure crop elsewhere, primarily Southeast Asia. People in India make cloth from its fibers.

Soil Dynamics Research Laboratory, Auburn, AL
D. Wayne Reeves, (334) 844-4741 Ext. 138

Giving each plant just the right amount of water and nutrients is the goal behind a new irrigation system being developed by ARS scientists. It's part of an emerging high-tech science called precision agriculture—providing water and fertilizer to plants based on their relative need, instead of applying uniform quantities across the whole field. Scientists started with a commercial center pivot irrigation system, which pivots in a giant circle, sprinkling plants underneath. Irrigation from these pipes is controlled by how fast it moves around the circle. But in two years of field tests, scientists modified the sprinkler system by dividing its length into several sections. Then they added to each section three manifolds that allow the water to be sprayed from nozzles at eight different rates. On a 15-acre field, researchers can precisely apply water and nutrients on up to 500 separate areas, each about the size of a two-car garage. The long-term goal: to allow farmers to pre-

cisely irrigate each part of a field, based on the type of soil and crop present in that area. Researchers are working cooperatively with Valmont Industries, Inc., a large manufacturer of commercial irrigation systems.

*Coastal Plain Soil, Water and Plant Research,
Florence, SC*

Carl R. Camp, Jr./E. John Sadler, (803) 669-5203

Cotton plants in Southern California can produce more cotton fiber if they take smaller, more frequent sips of the same amount of irrigation water they would normally get during July. ARS scientists developed and tested the new approach in California's Imperial Valley. In their three-year test, they applied just over 1-1/2 inches of water every five days during July, resulting in increased cotton yields by five to 11 percent. The new technique used no more water than traditional July regimens of three inches every 10 days, or 5 inches every 15 days. Some growers and others have believed the traditional regimen is necessary to flush away salt that can damage crops if it accumulates in the soil. But the scientists found that no salt accumulated in the top 6 inches of soil during the study. Why irrigate more often in July? The scientists say July is the peak time when cotton buds open up in the valley, and stresses such as inadequate water can strike yields especially hard. The scientists found that small, frequent irrigations keep plants in peak condition with lower leaf temperatures, high leaf moisture content and higher leaf transpiration rate.

*Irrigated Desert Research Station, Brawley, CA
Chang Chi Chu, (619) 344-4184*

A commonplace cultivator tool can help Pacific Northwest winter wheat growers "sweep" away about two-thirds of their potential downy-brome problem—a year before this costly weed could otherwise take over their wheat fields, ARS field studies have shown. The sweep cultivator is a broad, flat tool attached to a thin vertical shaft. Pulled by tractor, it increases seed contact with the soil and makes weeds germinate quickly. Weeds then can readily be killed by herbicide or cultivation in the fallow year. If growers don't act, however, the seeds stay dormant through winter and germinate the next fall, when wheat is again planted. Downy brome—also called cheatgrass—and other bromes infest 14 million of the 50 million acres of western winter wheat. The weeds cost growers \$300 million a year in lost yield. The sweep cultivator is ideal for wheat growers who use conservation tillage to cut erosion. That's because the sweep does not invert soil or chop straw left to shield the soil. For two wheat-fallow rotations, scientists measured survival of downy brome seed using five cultivation techniques. These were no-till, sweep, light harrow, shallow disc and skew-treader. In years with a dry fall, survival of downy brome seeds was only 13 percent with the sweep—and 40 percent

with no-till. In years with a wet fall, 3 percent of the seed survived with the sweep, and 9 percent with no-till. Harrowing was largely ineffective. Shallow discing cut seed survival dramatically, but buried much of the soil-protecting residue.

*Nonirrigated Agriculture Weed Science Research
Unit, Pullman, WA*

Alex Ogg, (509) 335-1551

Industrial (Non-food) Products

Red, papery peanut skins could someday find a place in hair conditioners and cosmetics. Researchers have discovered the peanut skins contain behenic acid, a fatty acid often used to give hair conditioners and moisturizers their smoothing properties. Used mainly in makeup and natural body-building products, behenic acid currently is extracted from rapeseed flour and sells for about \$8 a pound, depending on its purity. Another bonus: oil from the peanut skins, valued at about 43 cents per pound. Peanut skins typically sell for less than a penny a pound, but these findings could boost their value.

*National Peanut Research Center, Dawson, GA
Victor Sobolev, (912) 995-4441*

Computer Systems and Models

A computer model now under development will reveal the long-term impact of using grass hedges to stop soil movement from erosion and tillage. Five years of studies by ARS scientists have shown that grass hedges, planted along field contours, help keep soil on fields. That's good news for nearby streams and waterways that otherwise might become clogged with the runaway soil. The cropped areas above the hedges eventually form natural level bench terraces, reducing future runoff and erosion. The new model will help farmers and land planners design grass hedge systems and will predict topographic changes to fields over half a century of farming using grass hedges.

*National Sedimentation Laboratory, Oxford, MS
Seth Dabney, (601) 232-2975*

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Quarterly Report

of Selected Research Projects

January 1 to March 31, 1997

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Into the Marketplace

Patent Licenses

...To Yulex Corporation, Philadelphia, PA, to use an ARS-developed procedure to make hypoallergenic latex products from rubber of a shrub called guayule (pronounced "why-YOU-lee"). Guayule is native to the southwest and has been grown experimentally in California, Arizona, New Mexico, and Texas. Preliminary medical tests, conducted in collaboration with ARS, suggest that guayule-latex products should provide a safe alternative for individuals who are allergic to latex made from the most common source of natural rubber, the Brazilian rubber tree *Hevea brasiliensis*. It has been estimated that at least 20 million Americans suffer from *Hevea*-latex allergies. If they use *Hevea*-latex gloves, condoms, or other *Hevea* products, they may suffer allergy symptoms ranging from rashes and hives to life-

Contact the scientists listed for further information on each research project. For general questions about this report, contact Sean Adams, ARS Information, 6303 Ivy Lane, 4th Floor, Greenbelt, MD 20770, (301) 344-2723, sadams@asrr.arsusda.gov

Items marked with the word PATENT are being patented by ARS. For more information on patents, CRADAs and patent licenses, contact ARS Office of Technology Transfer, Bldg. 005, Rm. 416, BARC-West, Beltsville, MD 20705, (301) 504-5734. Questions about a company's product and/or research should be directed to the company itself.

This publication is available on the ARS Home Page at <http://www.ars.usda.gov/is/>

threatening anaphylactic shock. The idea of extracting natural rubber from guayule is not new, but the ARS team is the first to prove guayule's potential as a source of hypoallergenic latex. (PATENT 5,580,942)

ARS Contact: Katrina Cornish, Crop Improvement and Utilization Research Unit, Western Regional Research Center, Albany, CA, (510) 559-5950

Cooperative Research and Development Agreements

...With Pioneer Hi-Bred International, Inc., Johnston, IA, to develop commercial varieties of low-phytic-acid corn that should increase animal nutrition and lower phosphorus pollution in the swine, poultry and aquaculture industries. Corn, soybeans and other important feed and food crop plants store most of their phosphorus in the natural compound phytic acid. But animals with one stomach, such as pigs, chickens and fish—as well as people—can't break down phytic acid to get at the phosphorus. An ARS scientist discovered mutations in corn and other grains that cause the plant to store the nutrient in a more usable form. Phosphorus is essential for proper growth and strong bones, but unused phosphorus is excreted. Animal waste is often used to fertilize crops. But water runoff can carry phosphorus-laden particles into streams and lakes, where excessive phosphorus can cause algae blooms that choke out other aquatic life. ARS has developed more than 20 low-phytic-acid mutations. Pioneer is breeding the best of these into its own hybrids that have agronomically desirable traits. Preliminary tests show the new corn provides more phosphorus to animals and decreases the amount they excrete. The research may have human nutritional applications because phytic acid is believed to hinder the absorption of important minerals such as iron and zinc. This could be especially useful in underdeveloped countries where people depend on a largely grain-based diet. In developed countries, phosphorus deficiency is rare in people because diets generally include meat and other phosphorus-rich foods. (PATENT APPLICATION 08/215,065)

ARS Contact: Victor Raboy, National Small Grains Germplasm Research Facility, Aberdeen, ID, (208) 397-4162

...With Pioneer Hi-Bred International, Inc., Johnston, Iowa, to test corn plants that have altered forms of a gene important in corn pollen. ARS researchers isolated the gene, known as ZmPRK1. It is expressed

specifically in pollen, where it cues production of a protein known as a receptor kinase. Kinases may be important in cell-to-cell interactions such as those between a pollen grain and cells in female tissues during pollination and fertilization. If so, biotechnologists and plant breeders may try to manipulate the kinases as a new means to control pollination and fertilization. This could lead to superior commercial varieties or production practices. ARS scientists will study ZmPRK1 using corn plants isolated from Pioneer's TUSC collection (Trait Utility System for Corn). The system identifies naturally disrupted versions of corn genes. The affected plants will provide critical insights into the role or roles of ZmPRK1 during the life cycle of corn.

ARS Contact: Sheila McCormick, USDA-ARS/ University of California Plant Gene Expression Center, Albany, CA, (510) 559-5906, sheilamc@mendel.berkeley.edu

...With Gray*Star, Inc., Mt. Arlington, NJ, to evaluate a food irradiator for killing food borne pathogens like *E. coli* 0157:H7 on meat, poultry and other agricultural products. ARS scientists will help determine the uniformity—and factors affecting the uniformity—of doses of gamma irradiation delivered to agricultural commodities under controlled temperatures. They will test the effectiveness of the irradiator to control *E. coli* 0157:H7 as well as other food borne pathogens like *Listeria monocytogenes* and *salmonella*. Gray*Star's irradiator is transportable and can be delivered to the packinghouse or production site where food is being processed for shipment. The irradiator can handle up to 10,000 pounds of pre-packaged foods per hour and can process an entire pallet of product at once. Ionizing radiation from cobalt, cesium or X-rays kills harmful organisms, but does not cause food to be radioactive. The irradiator can also be used to control quarantine pests.

ARS contact: Donald W. Thayer, Eastern Regional Research Center, Wyndmoor, PA, (215) 233-6582

...With Gustafson, Inc., McKinney, TX, to pinpoint strains of beneficial soil-dwelling microorganisms called rhizobacteria that might boost both growth and disease resistance of strawberries and stonefruits such as peaches. Scientists will test rhizobacterial strains that enhance plant growth to see if these helpful bacteria also induce resistance to soil-borne diseases such as black root rot or a condition known as replant disorder. By improving plants' growth and resistance to disease, growers might be able to reduce their use of fumigants, such as methyl bromide. Today fumigants are needed to sterilize the soil and kill disease-causing soil microorganisms. In laboratory and greenhouse tests, ARS scientists will evaluate rhizobacteria samples from

Gustafson. The most promising strains might later be tested in small outdoor trials. The idea of using rhizobacteria to protect crops isn't new, but no strains have yet been commercialized to fend off microbial enemies of strawberries and stonefruits.

ARS Contact: Cynthia G. Eayre, Horticultural Crops Research Laboratory, Fresno, CA, (209) 453-3162, ceayre@asrr.arsusda.gov

Genetic Resources

Wheat varieties from the Middle East, such as Turkey and Iran, will provide the genetic base for U.S. varieties that resist powdery mildew. Researchers breed domestic red winter wheat with these wild varieties to create new hybrids. The hybrids themselves may not be suitable for growers, but can be bred with other varieties to create a winning combination of high yields and powdery mildew resistance. These hybrids demonstrated strong resistance to powdery mildew in three years of field tests. Seed is available from the National Plant Germplasm System.

*Plant Science Research, Raleigh, NC
Steve Leath, (919) 515-6819*

Waxy build-up may be bad on floors, but it could be good news if you're growing corn. Researchers found kernels of a corn line called GT:MAS:gk seem to have an unusually thick waxy outer layer. This appears to protect them from fungal invaders such as *Aspergillus flavus*, a contaminant of feed and sweet corn, and other commodities. This corn line's resistance to the fungus was observed years ago by ARS scientists, but until now researchers were unable to explain it. Analysis of the waxy covering shows it may be both a chemical and physical barrier to microbial attack.

*Southern Regional Research Center, New Orleans, LA
Robert Brown, (504) 286-4531*

Two new sugarcane varieties are giving Florida growers better production and new management options. One of the new varieties, CP 89-2143, has eight percent higher sucrose content and 17 percent higher sugar yields than CP 70-1133, a widely grown sugarcane cultivar. CP 89-2143 is suitable for either sandy or muck soils. It's already being used by Florida growers and is being tested elsewhere. The other new variety, CP 88-1540, was specially developed to meet the needs of producers with sandy soils. The bulk of previous sugarcane breeding research has been geared to production on muck soils.

*Sugarcane Field Station, Canal Point, FL
J.D. Miller, (561) 924-5227*

Onions may join the ranks of crops such as garlic that have a natural blood-thinning property to help slow down clotting and improve blood circulation. ARS researchers have developed the first genetic map of onions. This is an important step toward a whole new generation of publicly developed inbred onions to meet consumer demands for flavor and health benefits as well as grower requirements of yield, maturity, and disease resistance. Development of a commercial onion with these attributes could come within the next 10 years. University of Wisconsin scientists collaborated with the ARS scientists on the onion research.

*Vegetable Crops Research Unit, Madison, WI
Michael J. Havey, (608) 262-1830*

A new soybean cultivar named Athow resists multiple races of *Phytophthora sojae* plant pathogens and also promises early and plentiful yields. In performance tests in 1994-95, Athow's early-maturity beans produced more oil than the popular commercial soybean cultivars Flyer, Macon, Iroquois and Thorne, and it outyielded all but Iroquois. Developed cooperatively by ARS, Purdue University and the Illinois Agricultural Experiment Station, Athow also resists lodging—when the plant stalk snaps under the weight of the seed, making harvest more difficult. Athow seed will be available to qualified seed producers for 1997 planting. Samples of Athow germplasm are available for research, including development of other new cultivars. Named for longtime Purdue plant pathology professor Kirk L. Athow, the new cultivar is part of a continuing project to improve Midwestern soybean productivity.

*Crop Production and Pest Control Research, West Lafayette, IN
James Wilcox, (317) 494-8074*

Human Nutrition

Older people who want to lift their spirits and get more quality sleep might consider joining the local gym. In a 10-week study, regular resistance training significantly reduced depression and improved sleep in mildly to moderately depressed people in their 60's, 70's and 80's. Half of the 32 volunteers exercised leg, hip and upper torso muscles on pneumatic resistance equipment for 45 minutes three times each week, while the other 16—the control group—attended a health education meeting. Resistance on the exercise equipment was set at 80 percent of the maximum load each volunteer could complete in a single repetition on that day. At the end of the study, 14 of the 16 exercisers no longer met criteria for depression. Their depression scores improved two to three times above the control group, the researchers reported. Quality of sleep improved in more than one-third of the exercisers. The control group

reported no improvement. Elders are at high risk for depression because of the loss of health, function, loved ones, earning capacity and social worth. Progressive resistance training significantly improved the volunteers' strength, vitality, morale and ability to maintain social activities compared with the control group. This is the first controlled study to show that exercise is an effective antidote for depression and poor sleep in older men and women. And it's the first study to show that resistance training can improve sleep in any age group.

Jean Mayer USDA Human Nutrition Research Center on Aging at Tufts, Boston, MA

*Maria A. Fiatarone, (617) 556-3075,
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Equations used to estimate calories burned by adolescent females while resting are inaccurate for African Americans. That's what researchers found when they carefully measured the basal metabolic rate (BMR) of 76 white females and 42 black females between eight and 17 years old. BMR accounts for 50 to 70 percent of the calories we burn daily. Clinicians routinely use BMR to estimate the energy needs of patients. Government agencies use it to recommend calorie intakes. The researchers had suspected that the current equations do not reflect the energy needs of children and adolescents, particularly non-white youths, because they were derived from measurements done mostly on white adults. What's more, most of the measurements were done during the first half of the century, when equipment and methods were less sophisticated. Based on the new measurements, nine of the 10 equations evaluated significantly overestimated BMR in the black girls, and half overestimated BMR in the white girls. In six of the 10 equations, the overestimation was significantly greater for the black girls—averaging 77 calories daily—than for the white girls—averaging 25 calories daily. The researchers say ethnicity should be considered in future measurements of basal metabolic rate (BMR) and in refining equations used to estimate it.

*Children's Nutrition Research Center, Houston, TX
William W. Wong, (713) 798-7168,
wwong@bcm.tmc.edu*

A couple drops of blood are all that's needed to accurately assess a person's natural ability to fight off infections or suppress cancer, thanks to a new technique developed by an ARS immunologist. It could lead to routine screening of infants and children, the elderly and others whose immune competence may be suspect. The technique more closely mimics what happens inside the body because it tests the ability of a chemical stimulant or antigen to prompt infection-fighting T-cells to multiply in whole blood—a familiar environment—rather than among foreign proteins now

used to culture the T-cells. It requires only 0.4 milliliters or less of blood. That's one twenty-fifth of the amount now drawn, making the technique ideal for infants and small children and for people from cultures opposed to giving blood. Another plus: It's estimated to cost 35 to 40 percent less in equipment and supplies than the current technique. At the same time, it more than triples the number of samples that technicians can handle in one day. Also, the technicians need far less training to produce accurate readings because there's no need to separate cells from blood plasma or count them under a microscope.

*Beltsville Human Nutrition Research Center,
Beltsville, MD
Tim R. Kramer, (301) 504-8396,
kramer@307.usda.gov*

Diets high in antioxidant foods appear to protect the brain against oxidative damage, if rat studies are any indication. Oxidative damage is thought to be the culprit behind age-related disfunctions such as loss of memory or motor coordination. In the studies, rats that ate extracts of strawberries, blueberries or spinach as part of their daily diet fared far better on brain cell function tests than the animals getting chow alone. The fruit and vegetable extracts offered at least as much protection as vitamin E against oxidative damage. Earlier, these foods scored highest among commonly eaten fruits and vegetables in a "test-tube assay" of total antioxidant capacity. The next step was to assess their protective power in animals. In the first test, the scientists added either strawberry extract, vitamin E or nothing to the rats' normal diet for eight weeks. Then they put the animals in chambers under 100 percent oxygen for two days. High oxygen exposure alters brain function in young rats in a manner similar to the aging process. In both cases, brain cells are less sensitive to neurotransmitters, such as dopamine or norepinephrine, that prompt them to send or stop sending information. The scientists measured responses of brain function controlling memory, movement and growth of nerve cells. Decline in all three functions due to oxygen exposure was significantly—often dramatically—reduced by strawberry extract as well as by vitamin E. The scientists repeated the study using blueberry and spinach extracts. Preliminary data indicates that blueberry extract provides even more protection to rats' brains. Blueberries had the highest antioxidant capacity of the fruits and vegetables tested. If this finding holds up, it supports the usefulness of the chemical assay—known as ORAC—for identifying health-promoting foods.

*Jean Mayer USDA Human Nutrition Research Center
on Aging at Tufts, Boston, MA
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Girls and boys absorb two important bone-building minerals—calcium and magnesium—from snap beans as easily as they absorb them from milk, according to recent findings. That's good news to researchers at the ARS center in Houston. They are looking for good sources of calcium to replace the 24-35 percent drop in milk consumption among children and teenagers since the late 1970's. Snap beans are a popular vegetable among this age group. The researchers measured the rate of calcium absorption from milk and compared it with snap beans, broccoli and spinach in 12 girls and boys ages 9 to 14. They also looked at magnesium absorption from snap beans and spinach. Although it takes about five cups of cooked snap beans to equal the calcium in one cup of milk, the rate of absorption was the same from both sources. The absorption rate from broccoli was about 5 percent higher. One cup of broccoli provides about one quarter as much calcium as a cup of milk. But the calcium in spinach was poorly absorbed because of a high content of absorption-blocking compounds known as oxylates. The youths absorbed magnesium from snap beans, spinach and milk at about the same rate. Snap beans provide nearly as much magnesium as milk, but spinach provides nearly five times more. In a related test, the researchers collaborated with University of Wisconsin plant breeders to assess 64 unique types of snap beans, looking for differences in calcium content. They found wide differences, indicating that calcium content has a strong genetic basis. This means breeders can develop snap bean varieties with extra calcium. One discovery: The commercial snap bean variety "Hystyle" was among those with the highest calcium levels. In addition, the researchers found that younger, skinnier snap beans had significantly more calcium than older, fatter pods.

*Children's Nutrition Research Center, Houston, TX
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sabrams@bcm.tmc.edu, mgrusak@bcm.tmc.edu*

Older people whose heart rate soars and energy dives during aerobic exercise may want to take a closer look at their magnesium intake. A group of post-menopausal women experienced a significant drop in their work efficiency during a recent study in which their magnesium intake was reduced to a little more than half of the Recommended Dietary Allowance for three months. That occurred even though blood magnesium levels showed no sign of deficiency. According to the latest USDA nationwide food consumption survey, fewer than one-third of people over age 50 consume the recommended amount of magnesium through their diet, suggesting that a significant number get well below that level. The study was the first to look at the effect of a low magnesium intake on the physiological function of people over age 55. It affected the women's physiologi-

cal function in three ways as they cycled on an ergometer. First, they spent 10 to 15 percent more energy, as indicated by a rise in oxygen consumption, compared to when they were getting ample magnesium. Second, their heart rate increased about 10 beats a minute. And third, the amount of magnesium stored in their muscle tissue dropped measurably. But it's easy to get ample magnesium in a low-fat diet, the scientist said. Eat more vegetables, especially dark leafy greens, more whole wheat and other whole grain breads, cereals and pastas and more dried beans.

*Grand Forks Human Nutrition Research Center,
Grand Forks, ND*

*Henry C. Lukaski, (701) 795-8353,
hlukaski@gfhnrc.ars.usda.gov*

Food Safety and Quality

A faster, more accurate test to detect *Brucella melitensis* bacterium in unpasteurized goat's milk and cheese can help prevent undulant fever in humans.

That disease can cause chills, fever, fatigue and an aching similar to arthritis. Most food borne cases of undulant fever come from unpasteurized goat's milk and cheese from Mexico. A biotechnology technique called polymerase chain reaction (PCR) cuts the test's identification time in food samples from weeks to a single day. Quick identification is critical so contaminated foods can be removed from grocery stores. About two-thirds of all U.S. cases of undulant fever are attributed to infection with *B. melitensis*. (PATENT 5,447,844)

*National Animal Disease Center, Ames, IA
Betsy J. Bricker, (515) 239-8310*

To transform green sugarcane into those white, sweet sugar crystals on your breakfast table requires heat processing. But high temperatures can cause sugarcane's sucrose to break down and discolor, resulting in losses for the sugar industry. Researchers are working on improvements to processing machinery to help pinpoint and prevent heat breakdown. One discovery: As sucrose degrades, telltale chemicals called oligosaccharides form. Researchers say processors could check samples of sugar during processing and pinpoint sources of thermal breakdown where oligosaccharides are high. These production areas could then be studied and perhaps modified to reduce breakdown losses.

*Southern Regional Research Center, New Orleans, LA
Gillian Eggleston, (504) 286-4446*

Southwestern Arizona cotton growers have a new natural weapon in their fight against *Aspergillus flavus*. But the new weapon's identity may surprise some observers: It's another fungus from the same family as

the contaminating strain. This strain doesn't produce aflatoxin, but it can crowd out its harmful cousin. On fields treated with the benign fungus, aflatoxin levels in harvested cottonseed measured less than 20 parts per billion. By comparison, cottonseed from untreated fields nearby had as much as 180 parts per billion. Federal law prohibits selling any crop as a food source or dairy feed if it contains more than 20 parts per billion of aflatoxin. One part per billion is equal to one inch in 16,000 miles. This research is part of an on-going, three-year trial.

*Southern Regional Research Center, New Orleans, LA
Peter Cotty, (504) 286-4391*

To determine what happens when a cotton field is attacked by the fungus *Aspergillus flavus*, a USDA researcher is creating a greenhouse-sized model of an outbreak. Greenhouse conditions are kept dry and warm, which *A. flavus* seems to favor. Although the fungi's contaminant aflatoxin does not affect cotton quality or safety, it prevents the use of cottonseed—a valuable byproduct for animal feed. This goal is to find contributing factors that cause outbreaks, such as wind. Another possibility: the plant is using the fungi to supply chemicals unavailable in dry conditions.

*Southern Regional Research Center, New Orleans, LA
Maren Klich, (504) 286-4361*

Wanted: A high-energy beef snack to sustain military troops during times of great physical stress, such as combat or field maneuvers. ARS scientists are working on a new meat-stick formula that packs extra nutritional punch in the form of fat. A low-fat diet is normally recommended for healthy eating. But the ideal snack for high-demand physical activity would contain 40 percent fat for plenty of energy, plus 30 percent carbohydrates, 25 percent protein and 5 percent moisture. However, the high temperatures needed to make this product melt away the fat. Scientists say the solution is adding inner pea fiber to the beef. In tests, meat laced with inner pea fiber retained almost all of the fat during heating without affecting flavor. Pea fiber's fat-holding capability could prove useful in low-fat foods, too. That's because fat degrades over time, and any loss of fat in low-fat foods could mean loss of flavor.

*Meat Science Research Laboratory, Beltsville, MD
Brad Berry, (301) 504-8994*

Asian consumers favor bright yellow noodles with a chewy texture, and American wheat growers hunger for new market opportunities. ARS scientists are working to develop new hard white winter wheat varieties that could fill both demands by capturing the best qualities for oriental noodles. Most American wheat varieties were developed for bread making, which emphasizes different characteristics. The scientists are

developing white wheats with less amylose, a component of starch. Reduced amylose improves noodle palatability and also could extend shelf life of bread and baked goods. American scientists are using Japanese research findings to pinpoint how to breed a more Asian-friendly wheat. The research also will benefit American consumers who prefer hard white wheat, especially in whole grain breads.

Wheat, Sorghum and Forage Research, Lincoln, NE
Bob Graybosch, (402) 472-1563,
agro100@unlvm.unl.edu

IPM/Biological Control

Decisions on whether to apply insecticides to peach, apricot and other crops might be made easier by keeping tabs on the weather and monitoring sap beetle populations using traps containing synthetic versions of natural chemical attractants. By cutting out unnecessary chemical use, growers could help preserve the environment as well as their profit margin. The attractants first synthesized and patented by scientists of USDA's Agricultural Research Service were used by entomologists of ARS and New South Wales Agriculture in a five-year study in Australia. Sap beetles are found throughout the world and spread fruit-degrading fungi in a wide variety of crops. ARS scientists and colleagues around the world are studying ways to use attractants for environmentally friendly control of sap beetles in stored cacao and a wide variety of crops including figs, plums, pineapples and corn. One insect species trapped in the study was the confused sap beetle, *Carpophilus mutilatus*, also found in the United States. This species is believed to normally destroy about 10 percent of deglet noor dates in California and sometimes much larger portions of the bigger and more expensive medjool dates. The Australian researchers found minimal insect damage to stone fruit crops in years when lower-than-normal midsummer rainfall caused beetle populations to plummet and remain low until harvest. ARS is seeking more cooperators to speed development of sap beetle attractants in the United States.

National Center for Agricultural Utilization Research,
Peoria, IL
Robert J. Bartelt, (309)681-6237,
rbartelrj@ncaur1.ncaur.gov

Benign strains of harmful fungi that cause wilt disease in tomato crops are being explored as natural replacements for methyl bromide. Methyl bromide has many pesticidal uses, including as a soil fumigant. But it is scheduled to be banned in 2001 because it has been identified as contributing to depletion of Earth's ozone layer. Wilt is caused by virulent races of *Fusarium oxysporum* fungi. These fungi attack tomatoes, cantaloupe, watermelon and many other crops. But ARS scien-

tists have unearthed new strains of *Fusarium* that actually protect tomato plants from their disease-causing brethren. The beneficial strains induce plants to make natural chemical defenses. The chemicals kill or block virulent, disease-causing *Fusarium* fungi that try to infect the plants' water- and nutrient-carrying tubes. The good fungi aren't harmed because they reside solely on the roots. In greenhouse studies, up to 80 percent of tomato seedlings whose roots harbored the helpful microbes escaped the disease. Scientists began outdoor studies this spring on naturally infected tomato fields in Maryland. University researchers may also run tests in Florida. There, use of methyl bromide to protect tomato crops costs growers about \$220 per acre.

Biocontrol of Plant Diseases Laboratory, Beltsville,
MD

Bob Larkin/Deborah Fravel, (301) 504-5682

Mass production of a fungus that kills silverleaf whiteflies has doubled in efficiency in the past two years, thanks to improvements in the ARS-patented production technique. ARS scientists mixed *Paecilomyces fumosoroseus* spores with cornstarch, flour and sucrose before freeze-drying them. More than 80 percent of the spores were still viable after 5 months in storage. Now scientists at the Universidad Autonoma de Nuevo Leon, Monterrey, Mexico, are working with the ARS researchers to cut costs on the deep-tank fermentation of the fungal spores. Also under way: pinpointing the precise packaging and storage conditions needed to ensure the microbes will spring vigorously from their Rip Van Winkle state when mixed with water and sprayed on insect pests. The silverleaf whitefly, also known as strain B of the sweetpotato whitefly, is a pest of more than 300 plants worldwide. Since its discovery in this country in 1986, the tiny, sap-sucking insect has inflicted billions of dollars in damages on crops in Arizona, California, Texas and Florida. (PATENT APPLICATION 08/623,915)

National Center for Agricultural Utilization
Research, Peoria, IL
Mark Jackson, (309) 681-6283,
jacksoma@ncaur1.ncaur.gov

At Zephyr Egg near Tampa, Florida, you can walk into a poultry house and hardly see a house fly. That's because ARS scientists and University of Florida cooperators released a predatory fly—the black dump fly—that gobbles up house fly larvae that live in poultry manure. Each week for a year, the scientists released 70,000 black dump flies into the poultry houses at Zephyr. The company is one of the largest egg producers in Florida, with two million chickens that can produce up to 300 tons of wet manure a day. This is

heaven for house flies that breed in the manure. But a single dump fly larva can kill up to 20 house fly larvae a day. Soon after releasing the dump flies, the house flies had virtually disappeared. This meant Zephyr no longer had to spray an estimated \$12,000 a year in chemical pesticides to control the pests. And organic farmers are now interested in buying the chemical-free manure. The black dump fly, native to the United States, will kill more house fly larvae than it can eat, making it an excellent biocontrol insect. Another plus: Dump flies won't bother people. Black dump fly larvae will also eat the larvae of stable flies and other pests. Black dump flies are sold commercially in the United States, Canada and Europe, and have been used predominantly in the midwestern United States. But this is the first time the flies have been used as far south as Florida to control house flies in a commercial poultry house. ARS scientists are now working with a Florida poultry farm that wants to breed the flies in an on-the-farm insectary. The scientists also are also testing the dump flies for controlling pest flies in manure at dairy farms.

*Center for Medical, Agricultural and Veterinary Entomology, Gainesville, FL
Jerry Hogsette, (352) 374-5912*

A tiny wasp might help California cotton growers thwart cotton aphids. Last fall, ARS researchers and colleagues at California's Department of Food and Agriculture placed 1,700 wasps—known as *Aphelinus* near *paramali*—on cotton plants in a San Joaquin Valley field. The scientists now are checking to see if the insects survived to produce offspring. The female wasp pumps an egg into an aphid using her ovipositor, a tube-like appendage. The egg hatches into worm-like larva that feeds on the pest's innards, killing it. Sometimes, instead of laying an egg, the female wasp sips fluids that ooze from the wound made by her ovipositor. The cotton aphid, also known as melon aphid, secretes a sticky honeydew that contaminates cotton fibers. Sticky fibers can jam cotton gins or spinning equipment in textile mills, reducing the crop's value to growers. Besides cotton, this aphid threatens citrus and cucurbits such as cantaloupe, watermelon and squash by transmitting plant viruses. Among the viruses: citrus tristeza, watermelon mosaic virus and zucchini yellows mosaic virus. Wasps recruited for the California experiments are native to Florida. They were originally reared at an ARS lab in Orlando. The Orlando scientists were the first to recognize the wasp's potential as a natural enemy of cotton aphids and green peach aphids. They also were the first to lab-rear the wasp for greenhouse and field tests.

*Western Integrated Cropping Systems Research, Shafter, CA
John McLaughlin, (805) 746-8001,
jmclaughlin@lightspeed.net*

Tiny Italian fleas arrived in the United States this spring to start eating musk thistle. This spine-covered weed invaded from Europe 150 years ago. Today it infests millions of acres of pasture, range and other areas in 32 states. Musk thistle grows to 6 feet tall and chokes out forage and other desirable plants. Because of its spines, cattle won't graze near musk thistle, and the spines pose a prickly hazard for hikers. Herbicides are often too costly and can't be used near parks and similar areas. Scientists believe the best long-term strategy is to import the weed's natural enemies from "the old country" and develop thriving populations of musk-thistle eaters. The *Psylliodes chalcamera* flea beetles are the latest of four insects ARS and cooperating scientists imported to fight the weed. Adult flea beetles feed on the weed's rosette, or crown, and larvae feed on leaves and buds. Scientists first released the insects in Texas in March and Kansas in April. Next year, ARS scientists will supply flea beetles for releases in 20 other states. Before applying for USDA permits to import and release the insects, ARS scientists ran tests in Italy to determine that they have no appetite for important U.S. plant relatives of musk thistle, such as artichoke, chicory and native thistles.

*Grassland, Soil and Water Laboratory, Temple TX
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European Biological Control Lab, Montpellier,
France*

*Gaetano Campobasso, 011-39-620-609-346,
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Crop Productivity

A laboratory test could trim years off the time it takes to pinpoint new wheat varieties whose flour produces the most bread. The automated lab test—called reverse-phase high-performance liquid chromatography—can reveal within 8 hours the chemical makeup of dozens of flour samples. Researchers say hard red winter wheats that are rich in gamma gliadin proteins produce more loaves of bread per pound of flour. This gamma gliadin-loaf yield link holds true only in hard red winter wheats, the scientists note. The test can be run years before breeders typically can grow enough seeds of experimental wheat varieties to begin milling and baking tests. Milling companies might someday use the test to identify potential wheat purchases that would produce the best flour. Also noted: Growing environment as well as genetics affects wheat's protein composition.

*Biomaterials Processing Research, Peoria, IL
Floyd R. Huebner, (309) 681-6357*

A new gooseberry variety named Jahn's Prairie could give most of today's Americans a chance to enjoy this

plump, tart native fruit. Many wild gooseberry plants in the United States were destroyed decades ago because they can harbor a disease that threatened the pine industry. Jahn's Prairie, which resists the white pine blister rust, was selected from the wild by ARS and Canadian experts. Gooseberries are high in vitamin C and are popular in pies and preserves in England. They ripen the first week in July, and could spark new life into a developing commercial gooseberry industry in the United States. The industry was largely abandoned here in the 1940s when a federal law called for eliminating gooseberries and their cousins, currants, because of the rust. The law was repealed in 1966 but some states still prohibit growing the fruits. Gooseberries grow well in the Pacific Northwest, Midwest, the East and in Canada. The new variety also resists powdery mildew, a fungal disease of the leaves, stems and berries.

*National Clonal Germplasm Repository, Corvallis, OR
Kim E. Hummer, (541) 750-8712, hummerk@bcc.orst.edu*

A new germplasm line of great northern bean withstands both the rust fungus and bean common mosaic viruses. It also resists another disease, bean common mosaic necrosis. Scientists with ARS, Michigan State University, and the University of Nebraska developed the new line, called BelMiNeb-RMR-3. It is now available to plant breeders for developing new, high-yielding commercial varieties. The fungus and virus are culprits behind diseases that can claim 30 to 90 percent of a susceptible bean crop. Commercial varieties bred from the new line would be the first with resistance to all 87 available races of the rust fungus *Uromyces appendiculatus*, plus all 23 known strains of these mosaic viruses. Bean common mosaic necrosis is a destructive new virus that was accidentally introduced into the United States several years ago from Africa. The scientists developed the new line by selecting the most promising plants from a series of crosses using desirable, great northern bean cultivars or lines. In field tests, yields of large, white BelMiNeb beans nearly matched those of another popular variety, Starlight. The new line grows as an upright plant. This makes it less prone to attack from soilborne *Sclerotinia* fungi that cause white mold disease, particularly in recumbent bean plants.

*Molecular Plant Pathology Lab, Beltsville, MD
J. Rennie Stavely, (301) 504-6600*

Rice mills could someday collect more cash for their bran and broken kernels by extracting valuable protein from these low-value products. Bran is polished off brown rice kernels to produce white rice. Typically, the bran is sold as a feed additive for an average of two cents per pound. But a pound of rice bran contains about 60 grams of protein. Rice protein is used in foods as a flavor and nutrition enhancer. Only a

handful of companies worldwide now produce rice protein, with rice flour or grain rather than bran as their source. ARS scientists in New Orleans, LA, are exploring ways to retrieve the protein from rice bran—even from broken rice kernels, which typically sell for about seven cents per pound, compared with 24 cents per pound for whole kernels. One possibility: using enzymes to extract the protein. The extracted protein could be whipped into frothy textures that blend easily into food products such as dessert toppings to boost nutritional value. Another plus: Scientists speculate that rice protein may be hypoallergenic.

*Food Processing and Sensory Quality Research, New Orleans, LA
Elaine Champagne, (504) 286-4353*

Domestic peanuts could borrow resistance to diseases and pests from hardy wild peanut varieties, thanks to a new method of producing hybrid peanut plants. Earlier attempts were hampered by the sudden death of embryonic plants from apparently successful crosses. The new technique nurtures the plant embryo on a high-nutrient growth medium. Using this method, researchers have crossed domestic peanut lines with hardy wild varieties from Mexico.

*Market Quality and Handling, Raleigh, NC
Harold Pattee, (919) 515-6745*

Plants don't have bones, but they do contain a substance called lignin that helps them stand up straight. Unfortunately, tough, stringy lignin poses problems in feed quality and paper production. Now ARS researchers have discovered a gene that could change the structure of corn lignin so it disintegrates more easily. This information could be useful in developing plants that are more digestible as feed, yet still retain their natural lignin-linked pest resistance (more lignin means it's tougher for pests to munch). Researchers suspect the corn gene has a counterpart in pine trees used in making paper. Pine lignin that breaks down more easily could reduce the paper industry's current dependence on chemicals that can damage water quality.

*Plant Science Research Unit, Raleigh, NC
Paul Sisco, (919) 515-3309*

Telling good soldier flies from the bad ones just got easier. Many species of soldier flies are beneficial to agriculture because they help decompose plant material. But other species are pests of sod and wheat. For the first time, ARS scientists have compiled detailed descriptions of 33 genera of the subfamily *Beridinae* of the soldier fly family *Stratiomyidae*. The ARS monograph also proposes nine new genera, describes two new species and properly classifies many misplaced species for the first time. Each of the 33 genera described is diagnosed and a catalogue of world species and their geographic distribu-

tions is presented. The scientists present a hypothesis on the evolutionary relationships between genera and the placement of the subfamily with respect to other groups of flies. The monograph contains a comprehensive key to the genera as well as several regional keys to facilitate soldier fly identification. The publication includes illustrations of the head and genitalia of species of each genus for ease of identification. The monograph will be useful to scientists studying these flies and also will aid agents at U.S. ports of entry who monitor immigrant species that may be potential pests.

Systematic Entomology Laboratory, Museum of Natural History, Washington, DC
Norman E. Woodley, (202) 382-1802

Crop Diseases and Pests

Insecticide applications on stored wheat can be reduced or eliminated by timely cooling of the grain with automated fans. Computer simulation showed unaerated grain is a prime breeding ground for rusty grain beetles, especially unaerated wheat stored in bins of 10,000 bushels or more. The computer simulation showed an automatic aeration controller could keep insect populations below economically damaging levels without insecticides, even as far south as Oklahoma. Scientists say the automated system could be set to turn on fans whenever air temperature is 18 degrees F lower than grain temperature. The automated system suppresses insects by cooling the grain as soon as possible, and saves electricity and grain weight loss by cooling only when necessary.

Biological Research, Manhattan, KS
Paul W. Flinn, (913) 776-2707, flinn@usgrmrl.ksu.edu

The herbicide chlorsulfuron kills or slows growth of the roots of tall whitetop weeds—something other available herbicides can't do, say ARS scientists. Tall whitetop, also called perennial pepperweed, is an increasing problem in western native hay meadows. The weed is among the five worst noxious weeds in Nevada. Cattle there rely on native grass hay for winter feed. But they won't eat hay dominated by this weed. Several chemicals kill its flowering stalks and leaves, but range managers don't have a tool for killing its roots or slowing their spread. In the first two years of an ARS study, chlorsulfuron controlled the roots. Another advantage: Chlorsulfuron can be applied in the fall, while other popular herbicides such as 2,4-D must be applied in the spring, posing a threat to nesting waterfowl. Scientists suspect tall whitetop is spreading rapidly across the West, though its full extent is unknown. In one part of their study, ARS scientists monitored the weed's spread in 500 acres of privately owned grassland. Once whitetop invaded, it spread from zero to 100 acres

in five years.

Ecology of Temperate Desert Rangelands, Reno, NV
James Young, (702) 748-6057

Like the Greek monster Medusa's snaky tresses, "hairs" on plant surfaces can prove deadly to leaf rust spores that attack wheat and rye. Scientists say rust infestation has been reduced up to 27 percent in plants with hairy leaves. When spores of the culprit fungus *Puccinia recondita* land on leaves, they send out root-like structures called hyphae. These structures search for stomates—openings on the plant leaf surface through which the plant takes in vital carbon dioxide—as vulnerable spots to invade the plant. But if the hyphae can't find its way through the maze of leaf hairs, the spore dies before damage is done. Plant breeders could use this information in developing new crop varieties with built-in protection against rust disease, which costs wheat and rye growers millions of dollars annually in lost yields.

Cereal Rust Laboratory, St. Paul, MN
Dave L. Long, (612) 625-1284,
davidl@puccini.crl.umn.edu

A plum called Deep Purple might help almond growers who today can't produce the country's top almond variety—Nonpareil—because of root-destroying nematodes and soggy soils. Almond trees don't root readily and are susceptible to nematodes. To bypass these problems, almond budwood typically is grafted to botanical relatives such as peach (for well-drained orchards) or plum (for sodden sites). Nonpareil can't be grafted onto certain choice plum rootstocks, but preliminary ARS tests indicate Deep Purple might fit the bill. For the experiments, ARS scientists grafted budwood of several almond relatives onto Deep Purple rootstock. The grafts remain strong four years later. Also, Deep Purple outperformed other rootstocks in tolerating bacterial canker and two kinds of nematodes. A hardy plum introduced by the University of Minnesota in 1965, Deep Purple hadn't been tried before as rootstock for almonds. This spring, several dozen cuttings of Nonpareil budwood will be grafted onto Deep Purple rootstock for test plantings in California. That state produces 99 percent of America's almond harvest, worth more than \$1 billion to growers in 1996.

Horticultural Crops Research Lab, Fresno, CA
Craig A. Ledbetter, (209) 453-3064, jlitster@qnis.net

A new, inexpensive plastic trap could help farmers protect cotton and other crops from silverleaf whiteflies. First discovered in this country in 1986, the pests have cost U.S. agriculture more than \$1 billion dollars from 1990 to today. Scientists are evaluating the new traps to determine if a specified number of captured

adult whiteflies could help growers decide the need to apply insecticide or other control methods. The trap consists of a 12-ounce clear plastic cup inverted over a bright yellow base. ARS scientists who developed it have applied for patent protection. They initially tested the trap for monitoring whiteflies in western cotton fields. The scientists say the trap might also be used—along with parasitic wasps—in greenhouses to control whiteflies with little or no need for chemical insecticide. (PATENT APPLICATION 08/779,066)

*Western Cotton Research Laboratory, Phoenix, AZ
Chang-Chi Chu/Thomas J. Henneberry, (602) 379-3524, thenneb@asrr.arsusda.gov*

Animal Productivity

Feedlot managers want beef cattle to produce less lactic acid; producers of lactic acid for food and industrial uses want to beef up production while cutting costs. Both groups may get their wish as researchers move closer to solving a \$40-100 million headache for the U.S. beef industry. When cattle switch from a high-forage diet to a finishing ration loaded with energy-rich grains, they sometimes get lactic acidosis—a giant stomachache. Sometimes life-threatening, lactic acidosis inhibits animals' weight gain and results in liver abscesses and other abnormalities. That's because millions of the bacterium *Streptococcus bovis* in the rumen—the animal's stomach compartment—gobble up more glucose from the grain than they need and expel an abundance of lactic acid. ARS scientists have sorted out the composition of the *S. bovis* gene behind the enzyme that produces lactic acid. Through biotechnological tinkering with the gene, they may someday manipulate *S. bovis* to produce less lactic acid in cattle or transform some microbial species to make more lactic acid for manufacturing of products such as biodegradable plastic.

*Fermentation Biochemistry Research, Peoria, IL
Michael A. Cotta, (309) 681-6273*

Two new tidbits about piglets: The little porkers like it hot, and telltale hormones can reveal whether they're stressed or healthy. ARS researchers were the first to study the effects of temperature on luteinizing hormone (LH) and follicle-stimulating hormone (FSH). Both LH and FSH influence reproduction and are excreted by the pituitary gland. Newborn pigs are more comfortable in a hot environment, while cool temperatures create mild stress. These studies were "piggybacked" with results from other swine experiments on temperature and exposure to disease.

*Animal Physiology Research, Columbia, MO
Robert L. Matteri, (573) 882-1047*

If farmers want their livestock to eat more and gain more weight, they'd better make hay while the afternoon sun shines. A new study shows that sheep, goats and cattle all prefer grass hays harvested in the afternoon over those cut in the morning. A possible explanation: Plant carbohydrate production peaks at midday. Researchers suspect animals "remember" the afternoon-cut hays give them more energy than morning-cut hays. It's long been known livestock grazing peaks in the afternoon. This led researchers to explore whether cutting hay later in the day could boost consumption.

*Plant Science Research, Raleigh, NC
Dwight Fisher, (919) 515-7597*

The same natural substances that help pigs and other livestock cope with stress could make it more difficult for the animals to fight off common infections. ARS scientists have discovered that pigs agitated in simulated shipping conditions had higher levels of cannabinoids, a chemical produced by the brain that helps calm the pig. The bad news: The same tests indicate that when pigs' cannabinoid levels stayed high over a long period of time, their natural immune defenses were weakened. These findings could help animal breeders select the right pigs to stand up to stress, and also give growers important clues to possible causes of herd health problems.

*Livestock Behavior Research Unit, West Lafayette, IN
Gary Weesner, (317) 494-6983,
gweesner@ansc.purdue.edu*

Extra fat in a cow's diet for the last 6 weeks of pregnancy could help her newborn calf fare better in cold temperatures, according to preliminary results by ARS scientists. An estimated 95,000 calves die each year from cold stress. In tests, researchers added safflower with a high concentration of linoleic fatty acid to the diets of 12 cows for 53 days before calving. Another 11 ate a standard feed ration. For the first five hours after birth, the calves stayed at room temperature. Then they were put in a room at 32 degrees Fahrenheit. During this 140-minute experiment, calves from mothers that ate the extra fat maintained their body temperatures better than did those from cows fed the standard diet. The effect on calf survival is still under study. But the scientists believe the calves born to cows on the high-fat diet had more "brown" fat. Brown fat surrounds organs such as the kidneys and helps the animals generate body heat immediately after birth. Researchers are repeating the experiment to confirm the results.

*Fort Keogh Livestock and Range Research Lab, Miles City, MT
Robert Bellows, (406) 232-4970, bob@larl.ars.usda.gov*

Animal Diseases and Pests

The deworming product, levamisole, is transformed into other compounds in an animal's body, but almost all of these compounds pass out of the animal within two days. Levamisole is commonly used in sheep, swine and cattle, but has never been approved for use in cows producing milk. ARS scientists found that 48 hours after the animal has been treated, less than 1 percent of the levamisole and its residues was secreted into the milk and less than 5 percent remained that long in the cows' bodies—primarily in the liver. Most was eliminated through urine. The information will be useful to regulatory agencies deciding which "marker" compounds to monitor to help ensure food safety for consumers of dairy products.

*Animal Metabolism-Agricultural Chemicals Research,
Fargo, ND*

Vernon J. Feil, (701) 239-1236, feilv@ars.usda.gov

Soil, Water and Air Quality

Soil crusting from cropped soils can cause serious erosion problems due to increased runoff water. The best way to overcome this is by applying chemicals like gypsum and polyacrylamide (PAM) and increasing plant canopy surface cover. The two together, say ARS scientists who tested several solutions to surface soil crusting, are very effective in combating water runoff and soil loss on cultivated soils. After studying four crust-preventing practices (tillage, canopy cover, gypsum, and PAM) on six 11.5-by 3-foot field plots of Cecil soil under natural rainfall conditions, they found gypsum and PAM were effective in reducing both runoff and soil loss. Breaking surface crust by tillage worked for short, mild storms but was not as effective for high intensity storms. Canopy cover was much more efficient in reducing soil loss than in reducing runoff. By controlling surface sealing and crusting, more water infiltrates soil and less soil is lost by surface sealing. This information will be useful to farmers and land planners.

*National Soil Erosion Research, West Lafayette, IN
Mark Nearing, (317) 494-8683*

Native shrubs can be successfully planted on western lands being reclaimed after strip-mining operations. However, seeding rates may need to be increased and seeding methods may have to be improved to comply with reclamation requirements. ARS scientists examined seedings made by strip mining companies 10 to 15 years ago at 14 reclaimed sites throughout Wyoming. Areas seeded at 1,000 shrub seeds per square meter now have shrub densities of 0.6 per square meter. Areas seeded at lower rates had lower densities. The Wyoming state reclamation requirement is for one (1.0) shrub per square meter on 20 percent of the reclaimed surface. The scientists do not advise mining

companies to seed at rates higher than 1000 seeds per square meter because that does not appear to substantially increase shrub density. The original seedings were of fourwing saltbush, sagebrush, grass or a combination of these plants. Shrub density and composition varied by site, but typically reflected the seed mixtures used. Scientists say precipitation and temperature are significant variables in seeding success, especially with sagebrush. Some years, like 1993, are just right for sagebrush survival while other years resulted in less success. Scientists can't do much to control the weather but they are looking for methods to substitute for the 1993-like conditions. One such possibility might be to use a mulch to slow moisture loss and keep temperatures cooler in the summer.

*High Plains Grasslands Research, Cheyenne, WY
D. Terrance Booth, (307) 772-2433,
tbooth@lamar.colostate.edu*

Careful timing of corn ridge-till cultivation could allow farmers to cut back on insecticide treatments against corn rootworms. In ridge tilling, the cultivator throws dirt up around the base of the corn plant. Corn plants that had at least seven leaves before ridge tilling produced more brace roots, scientists found. Corn with a stronger brace root system is less likely to fall to the ground after rootworm damage. Because rootworm damage is usually restricted to older roots that are lower on the stem, new brace roots higher up on the plant may help corn plants tolerate some rootworm damage. In the three-year experiment, researchers found grain yields generally unaffected by ridge tilling. But when the tilling was postponed to the seven-leaf stage, ridging the soil increased the number of brace roots by five to eight roots.

*National Soil Tilth Laboratory, Ames, IA
Thomas C. Kaspar, (515) 294-8873, kaspar@nstl.gov*

For the first time, research has revealed how a small stream can contaminate an aquifer with agricultural chemicals. Walnut Creek, a tributary of the South Skunk River near Ames, Iowa, is a typical small stream. Before flowing into the river, the creek passes over a sand and gravel aquifer. ARS scientists confirmed the movement of water through the creek bed and into the underlying aquifer by measuring water levels in the aquifer and flow in the stream on two sampling dates. Chemical analyses of 24 water samples showed that the water entering the aquifer contained nitrate and herbicides, including atrazine. The researchers estimate that the creek could contribute up to 10,000 times more atrazine to the aquifer than leaching through a field with an area equal to that of the stream bed.

The stream and aquifer conditions studied are common in the Corn Belt. Alluvial aquifers, sometimes called "buried valley aquifers," are found near most major rivers in the Corn Belt.

*National Soil Tilth Laboratory, Ames, IA
Michael R. Burkart, (515) 294-5809*

The soil's ability to absorb sound waves can provide major clues to its physical characteristics, such as porosity or resistance to air flow. ARS scientists collaborated with specialists at the University of Mississippi's National Center for Physical Acoustics, Oxford, Mississippi, to develop a probe microphone and a procedure to help measure these characteristics. The procedure determines how well sound waves penetrate up to 4 inches of soil. The new technology allows the soil properties to be measured quickly without disturbing the soil profile by digging. The same technology also could help determine sediment concentrations in water flow--useful information in devising strategies for protecting stream beds from filling up with sediment.

*National Sedimentation Laboratory, Oxford, MS
Mathias J. Romkens, (601) 232-2927*

Industrial (Non-food) Products

Vernonia now has more potential as an industrial oilseed crop because ARS researchers have discovered how to breed varieties that will hold on to more of the seed until harvest. Vernonia oil might be used in environmentally friendly drying agents in paints. The industry wants alternatives to today's volatile organic compounds that are irritants and airborne contaminants. Unfortunately, vernonia's commercial development has been crippled because available varieties shed too many seeds. Last fall, ARS scientists discovered that some vernonia plants possess a petal-like device that holds the seeds upright. These plants retained more seeds. Scientists will cross-breed these plants this summer. This will reinforce the seed-holding trait and is the next step to higher yielding commercial varieties. The content of epoxy oils in vernonia, up to 40 percent, is double that of most other oilseeds like soybean and linseed. Vernonia oil also might be used in manufacturing more flexible plastics and in other resins like varnish.

*U.S. Water Conservation Laboratory, Phoenix, AZ
David A. Dierig, (602) 379-4356,
ddierig@uswcl.ars.ag.gov*

A procedure known as high-volume instrumentation is the cotton industry's standard tool for determining the length, strength and natural color of cotton. Adding another process--called near-infrared spectroscopy (NIR)--could also reveal bulk maturity, a characteristic that's key to how well the cotton will take dye.

Dye imperfections cost the U.S. cotton industry approximately \$200 million annually. NIR uses light wavelengths that the human eye can't see to detect otherwise invisible fiber qualities. NIR failed to win industry acceptance in the past because of shortcomings in speed and accuracy. Now researchers have improved the mechanical design. One improvement: The new system uses a larger cotton sample pressed against a bigger glass plate, where the light waves shoot through the fiber. The bigger sample helps reduce measurement errors. Also, the mathematical equations used to analyze the NIR readings have been fine-tuned. In tests, the improved NIR analysis showed less than 2 percent error in its ability to predict cotton maturity.

*Southern Regional Research Center, New Orleans, LA
Joe Montalvo, (504) 286-4249*

Computer Systems and Models

Good news for users of four ARS natural resource computer models: MOSES is coming to guide them. MOSES is the Modular Operational Soil Erosion System, a new state-of-the-art graphic interface program. ARS scientists are redesigning the way users generate and organize the information needed for simulated erosion predictions from the existing computer models. When completed, MOSES will link the Revised Universal Soil Loss Equation, the Water Erosion Prediction Project, the Revised Wind Erosion Equation and the Wind Erosion Prediction System--complete with color graphics and audio feedback. MOSES includes a "wizard" that leads users through input choices. The new interface should make it quicker, easier and more efficient for model users to enter information and interpret results. This will be especially helpful to users in the USDA Natural Resources Conservation Service and Forest Service and at the U.S. Department of Interior's Bureau of Land Management for solving erosion problems that are part of their agency's mission.

*National Soil Erosion Research Lab, West Lafayette, IN
Charles R. Meyer, (317) 494-8695*

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of Selected Research Projects

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Into the Marketplace

Cooperative Research and Development Agreements

...With Chosen Foods, LLC, of Turlock, CA, to create novel, molded snacks from fruit puree. The company will use starch molding technologies developed by ARS scientists to produce fruit-based snacks from apricot, peach, orange, grape and strawberry puree.

Contact the scientists listed for further information on each research project. For general questions about this report, contact Sean Adams, ARS Information, 6303 Ivy Lane, 4th Floor, Greenbelt, MD 20770, (301) 344-2723, sadams@asrr.arsusda.gov

Items marked with the word PATENT are being patented by ARS. For more information on patents, CRADAs and patent licenses, contact ARS Office of Technology Transfer, Bldg. 005, Rm. 416, BARC-West, Beltsville, MD 20705, (301) 504-5734. Questions about a company's product and/or research should be directed to the company itself.

This publication is available on the World Wide Web at <http://www.ars.usda.gov/is/>

Growers will benefit from extended processing periods for seasonal crops. Consumers will get more choices when it comes to healthful snacks.

ARS Contact: Tara McHugh, Western Regional Research Center, Albany, CA, (510) 559-5864, thm@pw.usda.gov

...With Agracetus, of Middleton, Wisconsin, to breed cotton varieties that produce higher-strength fibers. In the scheduled five-year research effort, ARS scientists are evaluating transgenic cotton plants produced by Agracetus, a unit of Monsanto. ARS scientists will select the most promising transgenic plants and cross them, through conventional breeding, with other varieties to develop cotton plants that produce fiber with higher strength than current varieties. Stronger cotton fiber is important to industry because new, high-speed machinery used to produce cotton yarn requires stronger fiber to work most effectively. This new technology has been driven by global competition that has forced manufacturers to produce more cotton yarn and fabric at less cost. Higher-strength fabric could give the United States an edge in the global textile market. U.S. cotton exports are expected to be 7-7.5 million bales in 1996-97--slightly less than the 7.7 million bales in 1995-96 and considerably lower than the near-record 9.4 million bales in 1994-95. Another factor: Clothing that's 100-percent cotton--but still wrinkle-resistant--has become more popular in recent years. But to achieve wrinkle resistance, manufactures must chemically treat the fabric, a process that can cause a 30- to 50-percent reduction in the fabric's strength. Scientists say this impact could be partly offset with fiber that starts out naturally stronger.

Coastal Plains Soil, Water and Plant Research Lab, Florence, SC

O. Lloyd May, (803) 669-5203, cotton@florence.ars.usda.gov

...With Monsanto Company, St. Louis, MO, to investigate use of a recently cloned gene to protect tomorrow's tomatoes, bell peppers and other crops against viruses. A team of ARS and University of California at Berkeley researchers were the first to find and copy the gene, called *N*. Scientists have known for more than 50 years that the gene gives tobacco plants natural protection against the virus that causes tobacco mosaic. This disease can stunt plant growth and reduce yields. More than 150 kinds of plants worldwide are vulnerable to the virus, which takes its name from the yellow and green splotches that form on leaves of infected plants. UC and ARS have a joint patent on the *N* gene and its potential new uses as a virus-fighter. (PATENT 5,571,706)

ARS contact: Barbara J. Baker, ARS/UC Berkeley Plant Gene Expression Center, Albany, CA, (510) 559-5900, bbaker@garnet.berkeley.edu

...With Wehah Farm, Inc., Richvale, CA, to create a new process that could boost the taste appeal of fat-free rice cakes. Flavors such as cheese typically are added in coatings applied to the outside of the cake. But this means the flavor ingredients may not reach all of the cake's puffed rice. ARS scientists aim to develop a new process that spreads the flavor evenly. Wehah markets rice cakes and other rice products under its Lundberg Family Farms label. Supermarket sales of rice cakes totaled about \$249 million in 1995.

ARS contact: William J. Orts, Western Regional Research Center, Albany, CA, (510) 559-5730, ortsw@pw.usda.gov

...With Kellogg Company, Battle Creek, Mich., to study processed wheat bran products' ability to reduce formation of colon cells thought to be precancerous. Scientists have known for more than a decade that lab animals fed raw wheat bran have fewer of these cancer precursor cells, known as aberrant colonic crypt cells. ARS scientists will use bran samples from Kellogg to determine if similar findings occur when lab animals eat processed bran. Wheat bran is the thin, fiber-rich outer layer of the wheat kernel. The bran is used in breakfast cereals, whole-wheat breads, and other products.

ARS contact: Wallace H. Yokoyama, Western Regional Research Center, Albany, CA, (510) 559-5695, wally@pw.usda.gov

...With Pioneer Hi-Bred International, Inc., Johnston, Iowa, to assist ARS and University of California at Berkeley researchers in scrutinizing key genes from corn. Certain genes that these scientists found and cloned may have an important role in orchestrating corn's growth. Biotechnologists might be able to restructure the genes to boost yields or enhance plants in other ways. The ARS and UC scientists will use Pioneer Hi-Bred's "Trait Utility System for Corn" (TUSC) to reveal the jobs these genes perform. TUSC relies on a tactic called the loss-of-function strategy, in which a gene is turned off in experimental plants. This reveals what role the gene would have played had it not been turned off. Though seemingly indirect, the approach ranks as one of the fastest ways to reveal which trait a gene controls. The TUSC technology employs genes known as jumping genes or transposons, which can land on a gene and knock it out of action.

ARS contact: Sarah C. Hake, ARS/UC Berkeley Plant Gene Expression Center, Albany, CA, (510) 559-5907, maizesh@nature.berkeley.edu

Lightweight concrete of the future might be made with an inexpensive aggregate made from wheat starch. A new ARS process converts the wheat starch into a tough, rubbery substance called an aquagel. The aquagel is combined with cement, which is then poured and cured. The resulting concrete could weigh only 50 to 90 percent as much as regular concrete. The low weight and high insulation value of the new concrete might make it suitable for soundproofing, thermal insulation, flooring, roofing tiles, pool decking and other applications in which low- to moderate-strength, nonstructural concrete often is preferred to normal-weight concrete. ARS' own tests indicate the new product has uniform density--an important property lacking in some lightweight concrete made with foams or foaming agents. The new aggregate also may require less energy and labor to produce. ARS has arranged for a non-USDA lab to test the new concrete's density, strength and other characteristics. (PATENT 5,595,595) *Western Regional Research Center, Albany, CA*
Gregory M. Glenn, (510) 559-5677, gmg@pw.usda.gov

Inexpensive bee traps, first developed by ARS scientists, now are being commercially used to capture honey bee swarms that are too close for comfort to homes, schools and recreation areas. In Tucson, AZ, a private firm uses the traps to protect areas such as the Desert Museum, Tucson International Airport and golf courses from the highly defensive Africanized strain of honey bees. It is inadvisable for homeowners to try to use the traps themselves because of the dangers associated with handling large numbers of possibly angry and defensive bees. ARS originally developed the traps and their accompanying lure to give advance warning of Africanized bees' presence. The traps, made from pressed wood pulp, resemble pots used in plant nurseries. The single entrance hole for bees can be plugged to trap them inside.

*Carl Hayden Bee Research Laboratory, Tucson, AZ
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Most commercial apple and pear growers in the Pacific Northwest now spray their trees with calcium, an ARS-developed treatment to reduce bitter pit, cork spot, alfalfa greening and internal breakdown--flaws that can leave the fruit unmarketable. The calcium treatments cost as little as 22 cents a tree per year. Without calcium sprays, up to half the harvest of some apple varieties like Braeburn could be culled before they reach the market. ARS researchers who developed the technology are still working to pinpoint the best time to apply the calcium. Growers currently spray by calendar dates. The research is funded partially by the Washington Tree Fruit Research Commission.
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Cotton that's harvested while very wet could still wind up with good marks for quality, thanks to an ARS-designed conveyor belt dryer now being adopted by U.S. cotton gins. The machine dries the cotton at a lower temperature for a longer time than a conventional tower dryer. This allows sufficient drying time without damaging the cotton. Two gins in Texas and one in Virginia are already using the dryer. Also, a kenaf processing plant in Mississippi uses the dryer to prepare kenaf for making a variety of products including textiles and paper. Kenaf is a bamboo-like relative of cotton. ARS is working with Cotton, Inc., of Raleigh, North

Carolina, to use the dryer on cotton seeds destined for cattle feed. They are developing technology to coat the seeds with wet starch and then dry them. The slick coat prevents the seeds from clumping together and jamming farm equipment. ARS scientists initially worked with the Chickasha Cotton Oil Company of Casa Grande, Arizona, to develop the dryer.

*Cotton Production and Processing Research,
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Genetic Resources

Lighter-colored potato chips that take less time and expense to process could be "in the bag" in the 21st century. ARS researchers developed new potato breeding lines by crossing a wild South American species, *Solanum raphanifolium*, with relatives of U.S. commercial potatoes. The new lines could help overcome changes that occur in potatoes during cold storage. Cold storage of commercial potatoes elevates the potato's sugar content, resulting in unacceptably dark chips. Potatoes are normally stored at 45 to 55 degrees F. Scientists found the new lines can be chipped directly from storage at 34 to 36 degrees F. The new lines are now available to federal, state and industry breeders.

*Vegetable Crops Research, Madison, WI
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Plant breeders now can get seed of three new lesquerella germplasm lines. This plant's seed oil could be a domestic alternative to widely used imported oils such as castor oil. The new, ARS-developed lines represent the first public release of lesquerella breeding material in the world. Potential cosmetic uses of the plant's seed oil include lipstick and shampoo, both of which now use imported castor oil. Castor oil also is now required in high-quality lubricants for racing cars and heavy equipment. Lesquerella is grown in the arid southwestern United States, where it is becoming a new income-producing crop for some farmers. The new germplasm lines have 2 percent more oil than other tested strains of the plant. Breeders can crossbreed the new lines with other lesquerella plants to add other improved traits such as better seed retention and faster

growth. Researchers and breeders may obtain small quantities of seed from ARS.

*U.S. Water Conservation Laboratory, Phoenix, AZ
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The damaging southern root-knot nematode, *Meloidogyne incognita*, may meet its match in the Scotch Bonnet pepper, one of the hottest peppers known. In search of resistance to the nematodes, scientists inoculated greenhouse-grown plants from a collection of Scotch Bonnet and Habanero pepper varieties with 3,000 nematodes each. They also planted the pepper varieties in fields already infested with the pests. Result: Some of the Scotch Bonnet varieties were highly resistant, but all of the Habanero peppers were susceptible. The scientists say the resistant Scotch Bonnets could lend some of their nematode resistance to the Habanero through plant breeding. Both the Scotch Bonnet and Habanero peppers are from the same species, *Capsicum chinense*. Scotch Bonnet and the fiery Habanero are used in spicy table sauces, cooked sauces, seasonings and other products.

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Vitamin-rich sweet desserts and drinks from America's largest native fruit, the pawpaw, could become available within the next decade. Scientists with ARS and more than a dozen universities are testing 28 existing pawpaw cultivars to find the best to develop into commercial varieties. Ripe green pawpaws weigh up to 2 pounds and are about 5 inches long. The bright yellow flesh has a custard-like consistency suitable for baby food and ice cream. The taste has hints of banana, avocado and pineapple. Kentucky State University is leading the effort to commercialize the fruit, in collaboration with the private PawPaw Foundation. ARS researchers are providing technology to propagate and preserve the germplasm. The researchers also are trying to expand the cultivated range of the fruit. So far, pawpaw trees are growing as well in their new Oregon home as they do in their native range from New York to Michigan and from Nebraska to the Florida panhandle. *National Clonal Germplasm Repository, Corvallis, OR
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Human Nutrition

What we eat in America isn't necessarily what we think we should eat. That's the bottom line from ARS' most recent nationwide food consumption survey. Two-thirds of adults think it's very important to choose a diet with plenty of vegetables and fruits--as stated in one of the Dietary Guidelines for Americans. But their survey responses, collected in 1994-95, showed consumption of these foods has increased only slightly since the late 1970's. Fruit intake is slightly below the minimum two servings recommended in USDA's Food Guide Pyramid. Vegetable intake is only slightly above the minimum three servings. And, veggie consumption leans more to french fries than to the dark green and yellow vegetables associated with health benefits. On the other hand, while grains form the base of the Food Pyramid, less than one-third of adults think eating plenty of breads, cereals, rice and pasta is very important. But consumption of these foods has jumped more than 40 percent since the late 1970's. Ninety percent of adults believe it's important to maintain a healthy weight. But 40 percent think they consume too many calories, and one-third are overweight. What's more, 28 percent of men and 44 percent of women report they rarely if ever exercise vigorously. Sugar and salt/sodium consumption also doesn't follow beliefs. Eighty-five percent of adults agree with dietary guidelines that advise a diet moderate in sugars. But Americans daily consume an average 19 teaspoons of sugar that is added to their foods--by beverage and food processors or by consumers themselves. These 19 teaspoons account for 15 percent of our total calories for the population as a whole, and a considerably higher percent for adolescents. As for sodium, men exceeded by two-thirds the recommended upper limit of 2,400 milligrams daily. That's from foods alone, not counting salt added at the table. Women's diets have less sodium than men's, but they still consume one-quarter more than the recommended limit from foods alone.

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Imagine ordering a carp-salad sandwich at your favorite deli. That scenario may be just around the proverbial corner, according to studies by ARS and University of Arkansas researchers. More than 60

percent of participants in consumer taste panels preferred the mild taste of canned bighead carp over tuna. They also said they'd pay at least as much for the product as for tuna. As prepared for this research, bighead carp is also healthful. Analyses show that it's lower in fat than white meat tuna packed in water. Plus, about 40 percent of the canned carp's fat is omega-3 acids, which can reduce the risk of heart disease and relieve the inflammation of rheumatoid arthritis and other inflammatory diseases. What's more, it's loaded with calcium. Bighead carp are a boney fish, which has kept them out of U.S. fresh fish markets, except those frequented by Asian shoppers. However, canning softens the bones, making them edible. Worldwide, this Chinese delicacy is the most eaten fish, and it's considered the Cadillac of fish in Asian countries. In the U.S., it is already swimming in many commercial catfish ponds, helping to control the growth of algae and other plankton. Bighead carp flourish on plankton, preferring it to fish food. So they don't compete with catfish--at least in the pond.

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A new ARS study now underway could help researchers more accurately identify nutritional needs of adults with non-progressive disabilities such as inactive polio, cerebral palsy, and accident-related paraplegia or quadriplegia. The new study, with 50 disabled volunteers, was prompted by an earlier study in which ARS scientists checked nutrient levels in blood samples from seven healthy, active adults, age 18 to 45, who have severe birth defects. The scientists compared the results with a group of 51 non-disabled adults. The findings: The disabled volunteers had an average of 9 percent higher total cholesterol and 16 percent higher LDL or "bad" cholesterol. In addition, their vitamin D, beta-carotene, and vitamin A levels averaged 44, 39 and 35 percent lower, respectively. Their average vitamin C levels were comparable to those of the non-disabled group. But scientists say this needs further investigation; two volunteers with disabilities had extremely low vitamin C.

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Peanuts, popcorn, whole-wheat crackers and other high-zinc foods could help some children learn and reason better. In an ARS-led study, daily zinc supplements enabled Chinese school children with very low body zinc levels to score better in perception, memory, reasoning and psychomotor skills such as eye-hand coordination. An ARS psychologist spearheaded the study with Chinese scientists because of earlier conflicting reports. Changes in zinc intake had affected measures of cognition in three studies of adults, but failed to do so in two studies of adolescent boys and girls. Findings of the new study--conducted in three poor, urban areas of China--support the adult studies, and have important implications for countries where low zinc intakes are common. They could also apply to the 10 percent of U.S. grade-school-age girls and six percent of boys who get less than half the Recommended Dietary Allowance of zinc through their diets. The RDA for this age group is 10 milligrams daily. The Chinese children, age six to nine years, were divided into three groups. One group took a 20-milligram zinc supplement daily for 10 weeks. A second group took the zinc supplement plus a micronutrient supplement containing all essential vitamins and minerals, except for zinc and four other minerals known to interfere with its absorption. A control group got only the micronutrients, to alleviate any other deficiency that could affect performance on the psychological tests. Before and after the supplement period, each child took a battery of computer-administered tasks to measure attention, perception, memory, reasoning and motor and spatial skills necessary for successful school performance. The children who got the zinc supplement or zinc plus the micronutrients had the most improved performance, especially in perception, memory and reasoning skills. In addition to peanuts, popcorn and whole wheat products, the most common source of zinc is red meat. Oysters are the richest source.

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Eating fruits and vegetables can be just as effective as taking vitamin C at helping the human body defuse oxygen radicals in the blood that can cause cell damage. Last year, a test developed by ARS scientists showed that strawberries and spinach scored highest among 40 common fruits and vegetables in total

antioxidant capacity. Next, the scientists wanted to find out whether those protective compounds could be absorbed by the human body through diet in large enough amounts to boost the blood's antioxidant profile. The researchers analyzed the blood of eight women in their 60s and 70s before and after eating five test meals. Each woman first ate a control meal with a low antioxidant content. Then, over the course of two months, the researchers added either a strawberry extract, a spinach extract, red wine or 1,250 milligrams of vitamin C to the control meal. The result: The strawberry and spinach extracts--drinks that were the equivalent of eight to 10 ounces of the produce--boosted the ability of the women's blood to defuse the oxygen radicals just as much as the vitamin C. Red wine raised antioxidant capacity by 15 percent above the control meal.

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An extra 200 milligrams of vitamin E daily could help older people fight infections, but bigger doses of the vitamin don't mean bigger benefits. The immune system declines with aging, contributing to increased infections. In a recent ARS study, men and women over age 65 who took daily vitamin E supplements improved their immune system's response to foreign antigens. Antigens prompt the body to produce antibodies. The 80 volunteers in the ARS study took either 60, 200 or 800 mg of vitamin E--or a look-alike placebo--each day for 4-1/2 months. Then they were given a standard test, called DTH, that measures the body's reaction to seven antigens injected into the skin. The DTH test indicates how well immune-system cells, called T cells, "remember" antigens they have seen before and how to respond to them. Compared with the placebo group, the group getting 200 mg daily--equivalent to 200 International Units--had a 65 percent increase in DTH response. Those taking 800 mg had a 49 percent increase. The 200-mg group also produced the most antibodies to three vaccines administered after the supplemental period. For example, their antibodies to hepatitis B virus were sixfold greater than those in the placebo group.

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Dieting can hinder specific protective cells in the body's immune system, even if the diet includes healthful meals. In a new ARS study, eight healthy women, age 28 to 41, cut their calorie intake in half for 15 weeks. The protective cells' activity dropped about 20 percent, researchers say. Called "natural killer cells," these cells help fight viruses and tumors. Physicians, dietitians and other healthcare professionals could use the new information to improve weight loss programs. Longer and more restrictive periods of dieting may further undermine the protective cells, scientists caution. An estimated 40 percent of American women and 25 percent of American men are trying to lose weight. Obesity increases risk of diabetes, cardiovascular disease, hypertension and other illnesses.

Western Human Nutrition Research Center, San Francisco, CA

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A new, high-quality food product made from grain blends will help meet the daily nutritional needs of hungry people in emergency and supplemental feeding programs overseas. Made from corn and soybeans, the precooked powdered food does not require further heating and is fortified with added vitamins and minerals to further increase its nutritional value. Adding tap water creates a porridge that is nutritious enough to serve as the only food source in emergency feeding situations. Since no cooking is required, the need for firewood—a scarce resource in many refugee situations—is reduced. The new blended foods may contain different combinations of grains, legume products and vegetable oil, depending on cost, but must provide 20 percent high-quality protein, 12 percent vegetable oil, 60 percent carbohydrate, and eight percent moisture. The new food product is a joint effort between ARS and USDA's Farm Service Agency, USAID, Private Voluntary Agencies and industry, and was developed for USAID's Food for Peace program.

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Food Safety and Quality

Fuji apples retain flavor and crispness for up to nine months after harvest now that the apple industry has adopted ARS research findings on storing the fruits.

Previously, this flavorful apple variety was available to consumers only during the fall harvest. No one knew how to keep it fresh for a lengthy market period. But, over six growing seasons, ARS scientists determined how to adapt controlled atmosphere (CA) conditions to maximize its benefits on Fuji apples. CA is a common industry technique used to extend storage life for other varieties of apples by modifying the concentration of the main gasses naturally present in air--oxygen, nitrogen, and carbon dioxide. Scientists analyzed the Fuji for changes in color, firmness, starch, sugar and acid content. Results: the best CA treatment for Fuji apples holds storage temperature at 34 degrees F. and maintains oxygen at one to 1.5 percent and carbon dioxide at one percent or less (Fujis are sensitive to this gas). Fuji apple production is rapidly expanding in Washington state. In 1992, Washington produced about 805,000 boxes of Fujis. By 1995, production had jumped to nearly 3.5 million boxes. This growing season, Washington production will jump to an estimated 7.1 million boxes. California, second in production, will yield an estimated 2.3 million boxes.

Tree Fruit Research Laboratory, Wenatchee, WA

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Ginning mills that remove cotton fibers from cotton seed do not threaten an area's air quality. That's the word from an ARS study of exhaust from gins in 11 states. The study found only very low emission levels of eight potentially hazardous materials such as arsenic, lead and mercury. None of the materials was present at levels exceeding federal clean air regulations, and only very low levels of agricultural chemicals were found. The ARS engineers concluded the only emission of concern was particles of cotton leaves, stems and fibers, as well as some soil particles with diameters of 10 microns or less. Cotton gins are generally a minor source of these particles compared to most other industries. The engineers are now modifying the most popular emission control device, known as a cyclone, so the ginning industry could meet more stringent air quality standards if enacted.

Southwestern Cotton Ginning Research

Laboratory, Mesilla Park, NM

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Human noses are superior to expensive electronic instruments when it comes to sniffing apples for freshness. Researchers are seeking better strategies for storing apples so consumers get tastier fruit. They want to pinpoint the best blend of oxygen and carbon dioxide for controlled-atmosphere storage, a standard industry technique. Electronic instruments measure volatiles, or aromas, given off by the stored apples to determine how well the apples are faring. But human noses can detect some key fruit aromas better than electronic ones.

Cooperators at Oregon State University in Corvallis trained 10 testers to rate apple aromas--just as wine connoisseurs rate fine wines--using terms like "fruity" and "musty." So far, they've noted that fruit and floral aromas in Gala apples lose their pizzazz after 11 weeks in storage. The researchers' next step: finding the best gas levels so fruit stays both firm and aromatically appealing.

Tree Fruit Research Laboratory, Wenatchee, WA

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Scientists have devised a new lab test that quickly identifies whether a natural yeast strain has the potential to control aflatoxin on tree nuts. Aflatoxin, produced by *Aspergillus* fungi, is a known carcinogen. The fungus can infect tree nuts such as almonds, walnuts and pistachios along with peanuts, corn and cottonseed. To safeguard food and feed safety, government agencies monitor and limit aflatoxin levels. Last year, ARS scientists first discovered that some yeasts can reduce *Aspergillus* populations and toxin production on nuts. But finding the most effective yeasts among hundreds of natural strains has required costly, time-consuming chemical analyses. With their new test, the scientists need only see what happens after they put into a lab dish both a candidate yeast and a special *Aspergillus* strain. This strain, developed by other researchers in the 1980's, has a genetic mutation. It forms a red-orange pigment as a nontoxic precursor to making aflatoxin. If a candidate yeast blocks aflatoxin synthesis, the fungi won't make this pigment. Instead, only the white color of spreading yeast appears. That tells researchers the yeast is worth a closer look. This summer they hope to conduct greenhouse tests of the most effective strains--yeasts in the *Pichia* genus.

Western Regional Research Center, Albany, CA

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IPM/Biological Control

An insect chemical that prompts corn seedlings to send out a distress signal has been chemically isolated, identified and artificially reproduced by ARS and cooperating scientists. The chemical, called volicitin, is secreted in the saliva of beet armyworm caterpillars and other similar pests that feed on crops. The researchers say volicitin causes plants to produce chemical aromas, which in turn lure beneficial insects to attack the crop pests. The finding is the latest in an ongoing research effort to find environmentally friendly ways to control crop pests. In lab studies, scientists extracted volicitin from the saliva of beet armyworms. The researchers then cut corn seedling leaves and dabbed volicitin onto the damaged leaf areas. The researchers found that volicitin induced the seedlings to give off chemical aromas that act like distress signals. The plant chemicals lured a beneficial wasp, *Cotesia marginiventris*, that attacked the caterpillar pests. Simply damaging the seedling leaves--without adding volicitin--did not induce the same "SOS" response. ARS has filed a patent application on the volicitin compound. Scientists said the discovery could help plant breeders develop new crop varieties with enhanced chemical defense systems. Plants would be better able to attract beneficial insects that could fend off the attacking pests, cutting down on pest damage and allowing farmers to reduce pesticide applications to control crop pests. (PATENT APPLICATION 08/757,701)

Center for Medical, Agricultural and Veterinary Entomology, Gainesville, FL
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An organism that infects fire ants with a slow-acting disease has been discovered for the first time in the United States. The organism, called *Thelohania solenopsae*, is a microsporidium that the queen spreads to her offspring through her eggs. Ants thus are infected with spores that, over several years, weaken and kill the colony. *T. solenopsae*, discovered in Brazil in 1973 and found in other areas of South America, was discovered in the United States in 1996. Scientists are studying the microsporidium as a potential biological control for fire ants in the United States. In South America, fire ant population densities are reduced in areas where *T. solenopsae* is found. Scientists are now studying ways to mass-produce the organism for field tests in Florida. Fire

ants are thought to have spread to the United States in the 1930s and now infest 278 million acres in 11 southern states and Puerto Rico.

Center for Medical, Agricultural and Veterinary Entomology, Gainesville, FL
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A parasitic wasp and its "partner," a virus, may help cotton growers spare innocent beneficial bugs in the battle against beet armyworms. As caterpillars, beet armyworms feed on leaves and bolls of cotton plants. They also attack soybeans, corn, vegetables and other crops. To counterattack the pests in heavily infested cotton fields, growers typically spray insecticide. But this can wipe out helpful insect predators like big-eyed bugs. These beneficial bugs could prevent minor pests from becoming greater threats and filling the niche left by deceased armyworms. ARS researchers devised a more predator-friendly approach by teaming up the armyworm's two most formidable natural enemies: a parasitic wasp called *Cotesia marginiventris*, and a nuclear polyhedrosis virus. Female *Cotesia* wasps lay eggs inside the worms; these hatch and devour the worm. The virus kills by liquefying the worm's tissues, but it is harmless to people, animals, big-eyed bugs and other beneficial insects including *Cotesia*. In field studies, spraying the virus onto cotton plants killed 50 percent of the worms, and releasing 500 *Cotesia* wasps on the 5-acre plot doomed half the survivors. All told, three-fourths of the armyworms died. More studies are planned this summer in Texas.

Biological Control and Mass Rearing Research, Mississippi State, MS
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Pitting "good guy" insects against bad bugs that attack crops may sound like a simple idea, but it's not always so simple to put into action. For starters, there's the dilemma of raising sufficient numbers of the beneficial insects: What--and how--do you feed them? Now ARS scientists have developed an artificial diet for certain beneficial bugs for use in Florida's diverse agriculture. The recipe calls for liver and ground beef, plus other components that can be used to rear a variety of beneficial wasps and predators of crop pests. The ARS scientists have applied for a patent on the diet. The ARS scientists next will tackle the problem of packaging the diet. They'll work with scientists at Analytical Research Systems, Inc., of Micanopy, Florida, to test

different types of polymer film coatings to contain and protect servings of the diet. The scientists want to be sure the insects can pierce the coatings and get to the food inside. In cooperation with Predation, Inc., of Alachua, Florida, ARS scientists have reared a parasitic wasp, *Diapetimorpha introita*, and a predator called the spined soldier bug, on the artificial diet. The main stumbling block so far: relatively low egg production from adult bugs reared on the artificial diet. The scientists are working to further refine the diet and pinpoint the cause of the low fecundity. (PATENT APPLICATION 08/692,565)

Center for Medical, Agricultural and Veterinary Entomology, Gainesville, FL
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What do a natural insect virus, sugar and cottonseed oil all have in common? All are key ingredients in an experimental biopesticide that can be sprayed onto cotton plants to kill leaf-chomping beet armyworms. ARS researchers are exploring the approach as a natural alternative to conventional insecticides. Unchecked, armyworms devour the cotton plant's leaves and bolls, which produce lint, the fluffy white fiber growers harvest. In early field tests, the biopesticide killed about 60 percent of the armyworm caterpillars on cotton plants within four days. The biopesticide is made of a natural pathogen, called a nuclear polyhedrosis virus. If an armyworm swallows the virus, it destroys the insect's tissues and blood-like hemolymph. But the virus is harmless to humans, animals and beneficial insects. To ensure the worm ingests a fatal dose, the researchers use a feeding stimulant made of sugar and cottonseed oil, which the pest finds hard to resist. This summer, researchers will team with industry scientists to conduct another round of outdoor studies.

Southern Insect Management Research Laboratory, Stoneville, MS
Doug Street/Randy Bell, (601) 686-5231

A new ARS-developed lab test kit reveals if crop-destroying silverleaf whiteflies are being gobbled by beneficial bugs released into the fields. The test is a new tool in the search for effective natural alternatives to insecticides. Known as the "predator gut content immunoassay," the kit can tell if a beneficial insect has eaten even one whitefly egg. The kit deploys a team of sensitive, custom-built molecules that bind only with a

specific protein found in the silverleaf whitefly. Since 1986, this whitefly has cost U.S. agriculture billions of dollars in lost crop yields and quality, insecticide expenses and related economic disruptions. The scientists aim to expand use of the "gut-check" technology. Then they can more accurately evaluate the effectiveness of releasing large numbers of lab-reared biocontrol insects to battle whiteflies and other pests. *Western Cotton Research Laboratory, Phoenix, AZ*
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Codling moth, the world's most destructive pest of pome fruits, is being controlled in the western United States through a cooperative program based on ARS technology for disrupting the pests' mating. Now in the third year of the five-year Codling Moth Areawide Suppression Program, some growers have eliminated the need for insecticide sprays. The principal method of control is mating disruption, a technology that was developed by ARS researchers. Growers place a synthetic female sex attractant, or pheromone, in dispensers that emit the chemical throughout orchards. Male codling moths, confused by the pheromone, can't find the females. The areawide program initially involved 2,800 acres. This year it has grown to include more than 10,000 acres.

Yakima Agricultural Research Lab, Wapato, WA
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Venom from a tiny parasitic wasp may lead to an effective biocontrol agent for agricultural insect pests that cause hundreds of millions of dollars annually in crop damage. Venom from *Euplectrus comstockii* stops larval growth of a variety of devastating crop pests, including cotton bollworms, tomato budworms, tobacco budworms and corn earworms. The venom is particularly useful because leaf-eating *Heliothis* insects are most damaging during their larval or caterpillar stage. ARS researchers have isolated and identified the active ingredient in the wasp venom. The next step is to insert the venom into an insect virus. When applied to crops, the virus will carry the venom to the pests without harming the plants. This process makes use of two biological means (the venom and the virus) to control pest insects.

Biological Control of Insects Research Lab, Columbia, MO
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Crop Productivity

Commercial seed companies in Texas, Arkansas and other southern states have requested 201,500 pounds of seed to grow Jefferson, a new, long-grain rice cultivar developed by ARS scientists. In 1996, the researchers released about a thousand acres' worth of Jefferson seed to the Texas Rice Improvement Association. The association propagates supplies for commercial seed companies that produce the seed growers will plant. Earlier this year, the association sold the companies more than \$160,000 worth of Jefferson seed. The new cultivar's popularity stems from potent genes that protect it from two of the worst fungal diseases of rice, sheath blight and blast. Blight is caused by *Rhizoctonia solani* fungi. The blast culprit is *Pyricularia grisea*. Both diseases are prevalent in the South as well as around the world. Severe outbreaks can cause losses of up to 50 percent. Jefferson offers yield, milling and cooking qualities comparable to the popular commercial varieties Cypress and Gulfmont. But growers can harvest a second (ratoon) crop from Jefferson 1 to 2 weeks sooner--a boon in Gulf Coast states during the hurricane season.

Rice Research Unit, Beaumont, TX
Anna McClung, (409) 752-5221

Some like it cold--including seeds of winterfat, a nutritious native rangeland shrub. The seed should be chilled to zero degrees F to keep it in peak condition during long-term storage. Twenty years ago, scientists recommended winterfat seed be stored at 41 degrees F. They now know that seed stored at 41 degrees retains its ability to sprout, but that it loses vigor. Zero-degree storage of winterfat seed (*Eurotia lanata*), and of some other shrubs' seed, prevents age-related changes that occur at warmer temperatures. Scientists found that after two years of storage at 41 degrees, micro-structures like mitochondria and other organelles inside the cells of the winterfat seed embryo began to break down. They were able to see those changes with an electron microscope. When mitochondria age, they become less efficient at converting sugar to energy, so sprouting and growth take longer. Seed usually is tested by its ability to sprout, but a growth test is a better indicator of winterfat seed vigor. *High Plains Grasslands Research, Cheyenne, WY*
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Crop Diseases and Pests

The growth of some weeds like jointed goatgrass and downy brome was reduced up to 75 percent when researchers tried new, easy-to-use farming practices. They discovered that if they could get winter wheat plants to shade the weeds, the wheat would beat out the weeds. One solution: planting a taller wheat variety like Lamar. Growers traditionally have planted shorter varieties such as Tam 107 and Vona. Seeding wheat at 65 pounds per acre instead of the typical 40 pounds also helped shade out weeds.

Central Great Plains Research Station, Akron, CO
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A new diagnostic test has been developed by ARS and university researchers to identify the mystery insect that spreads "yellow vine." Since 1991, outbreaks of this new disease have caused losses of up to 100 percent in watermelon and other cucurbit crops grown in Oklahoma and central Texas. Melon growers there have had little success fighting the disease, which can cause fruit losses of up to \$4,000 per acre. Without knowing the insect carrier's identity, migration or feeding patterns, growers can't effectively use insecticides, repellent mulches or other crop protecting tactics. Initially, researchers conducted lengthy greenhouse studies to determine which cucurbit-loving insects could infect melon plants through feeding. Some of these included squash bugs, leaf hoppers and aphids. But few conclusive leads surfaced. This spring, the researchers will use a different approach. Using their new diagnostic test, they will screen the insects' tissues for genetic "evidence" of the culprit that causes yellow vine: a bacterium-like organism (BLO). Key to their approach is a sensitive molecular technique called polymerase chain reaction (PCR). It copies the organism's unique, DNA "fingerprint" millions of times over so it can be identified. Use of PCR will determine in one to two days whether an insect specimen--or weed it may feed on--harbors the organism.

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The bacterium that causes fire blight in fruit trees doesn't linger in a tree's older vascular system in sufficient numbers to cause disease. ARS scientists made this discovery using two aseptic, whole tree

arborspheres—a kind of plastic growth chamber. Much research has been done on this disease that attacks young fruit trees, especially apple and pear. It causes leaves and fruit to shrivel and blacken as though scorched by fire. But it was not known whether the disease-causing organism, *Erwinia amylovora*, lived in the limbs of the tree or if it reinfects the tree each season. The arborspheres were constructed in a test orchard, keeping two Rome beauty apple trees under sterile conditions for three months. Test trees were heavily pruned and cankers or damaged bark that might house bacteria were removed. No bacteria were found when the arborspheres were removed. Control trees close by that had not been kept in sterile conditions showed signs of fire blight. The research showed that heavy pruning causes an overabundance of new, tender shoots that are more susceptible to fire blight infection. So, when trees are dormant, growers should remove only the blighted shoots and large cankers caused by bacteria. Proper pruning should ensure adequate light penetration into the tree canopy to maintain good tree growth.

*Appalachian Fruit Research Lab, Kearneysville, WV
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Gamma ray energy needed for quarantine treatments against fruit flies could be lowered by half or more, ARS studies show. If expanded tests confirm this finding, irradiation would be more practical as an alternative to methyl bromide, a widely used fumigant set to be phased out by 2001. Effective quarantine treatments are essential. They ensure that Mexican fruit flies, Mediterranean fruit flies and related pests don't go along for the ride--and spread--when citrus or other fresh produce arrives at markets. Irradiation leaves no residue in fruit, but disrupts the insects' development so they can't reproduce. Currently, Hawaiian papayas and other tropical fruits are approved for shipping to Chicago. Exposure to 250 Grays (Gy) of gamma rays stops any stowaway oriental or Mediterranean fruit flies in the fruit. To ensure the innermost fruits in the load get 250 Gy, earlier tests showed that a dose level up to 750 Gy would be needed--but this level can damage orange, mango, grape, avocado, olive and other fruits. Preliminary ARS lab tests indicate that only 50 Gy may be needed to halt Mexican fruit flies in grapefruit shipments. Lower irradiation levels would translate to faster, cheaper treatments for more kinds of fruits. Plus, the fruit could arrive sooner at the supermarket--with more of its harvest quality intact.

*Crop Quality and Fruit Insects Research, Weslaco, TX
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A new high-tech defense protects peanut plants from attack by lesser cornstalk borers, cutting the need for chemical pesticides. The key to this new defense is a toxin-making gene that can be "borrowed" from the naturally occurring bacterium *Bacillus thuringiensis* (Bt). A team of scientists from ARS, the University of Georgia and Mycogen, Inc., used a biotech procedure to insert Bt genes into peanut cells, producing plants that carry the gene to make the Bt toxin. The toxin acts as a natural insecticide in the peanut plant's leaves, stem and roots, where the borer feeds. When borer caterpillars eat enough of the toxin, it kills them or slows down their growth and development into adult moths. In lab experiments, all the corn borer caterpillars died after eating leaves from plants with the Bt gene. But Bt's insecticide is harmless to people, animals and beneficial insects like bees. Field studies begun earlier this summer could help set the stage for developing new, commercial cultivars of Bt-engineered peanuts. Currently, growers apply granular insecticides to soil to kill the borer, a crop threat during hot, dry weather. The borer also can spread *Aspergillus flavus*, the fungus responsible for producing aflatoxin, a contaminant that can make peanuts unfit for human consumption.

*Plant Resistance/Germplasm Enhancement Research,
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Animal Productivity

Swine producers could someday live high off the hog if ARS and University of Missouri researchers learn how to control a newly-discovered obesity gene and its hormonal product, leptin. Leptin, found in fat cells, depresses appetite; the more leptin a pig has, the less it's likely to eat. The ARS researchers were the first to discover and clone three different forms of the leptin gene product in the pigs' fat cells. If leptin levels in pigs can be regulated--either through management practices or with feed modifications--producers could pack more marketable pounds on their pigs.

*Animal Physiology Research Unit, Columbia, MO
Robert Matteri, (573) 882-1047*

A computer simulation model is teaching farmers, farm consultants, and educators to better manage dairy operations. Created by ARS researchers, the Dairy Forage System Model--DAFOSYM--simulates the integration of feed production and manure handling with other farm components for dairy farms in the northern U.S. The model provides a unique tool for measuring the impact of changes on the long term performance and economics of dairy farms. DAFOSYM is now available on the Internet at <http://www.dfrc.wisc.edu>.

*U.S. Dairy Forage Research Center, Madison, WI
C. Alan Rotz, (517) 353-1758*

Cattle raisers may wisely include birthing ease among criteria for selecting breeding animals, according to ARS research. Having a herd in which first-time mothers calve easily will save labor and veterinary costs, ensure more calves survive and grow well and help cows continue reproducing in good health. In the recent four-year study, calving assistance was required 24 percent less frequently among young cows scientists had selected based on their ancestral records for calving ease dating back to 1978. Additional criteria included growth and indirect measures that affect calving ease such as lower birth weight. Even though the average birth weight of calves born to easy-calving two-year-olds was 6.6 pounds lighter than calves from unselected breeding lines, yearling weight was not affected.

*U.S. Meat Animal Research Center, Clay Center, NE
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Farmers now can pinpoint high-producing bulls and cows three months sooner. That's because ARS has doubled the frequency--from semi-annually to quarterly--of its reports evaluating dairy breeding animals. The reports show which breeding animals have outstanding milk yield, milk composition and other valuable traits. Farmers and businesses specializing in artificial insemination and embryo transfer rely on these evaluations. With more frequent reports, producers can stay more competitive because they can act twice as fast in response to the latest information on top-performing cows and bulls. As a result, these producers can obtain more offspring from the animals over time. Identifying key performers sooner also helps domestic dairy producers stay competitive in the international market. That's important: other countries also are increasing their number of evaluations. The ARS reports evaluate each breeding animal based on data from the Dairy Herd

Improvement Association program. ARS scientists analyze the data and prepare and distribute the reports. *Animal Improvement Programs Laboratory, Beltsville, MD*

*Duane Norman, (301) 504-8334,
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One hundred fifty alfalfa leafcutter bees perform as well as 3,000 domesticated honeybees when pollinating carrots in screened enclosures or greenhouses, an ARS study in Idaho has shown. The ARS study was the first to pinpoint precisely how efficient leafcutter bees were in comparison with honeybees for pollinating carrots in enclosed cages. Carrot breeders developing new, tastier or more nutritious varieties use the screened enclosures to keep out unwanted pollen. Alfalfa leafcutter bees are gentler than domesticated honeybees and aren't vulnerable to two mite species that have destroyed many commercial honeybees in recent years. Plus, the honeybees can become irritable when confined in large numbers to small spaces like greenhouses. Alfalfa leafcutter bees generally don't buzz annoyingly close to or land on people working in the enclosures.

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New information about elk could someday help rangeland cattle bear healthier calves even if the cows have eaten Ponderosa pine needles during pregnancy. The pines, common on Western grazing lands, cover 27 million acres in the United States. When pregnant cattle eat Ponderosa pine needles in the last trimester, blood flow to the uterus decreases dramatically. The cow delivers early, and her calves often die. Now, ARS scientists have discovered that pregnant elk that eat the needles show no reproductive problems or constriction in their blood vessels. The scientists believe natural microorganisms in the elk rumen--the first of four stomachs in many grazing animals--render the needles harmless. They are working to determine the differences between elk and cow rumen flora, with the goal of reducing or eliminating the needles' toxic effects. They are also evaluating bighorn sheep and white-tailed deer for tolerance to the pine needles.

*Fort Keogh Livestock and Range Research Laboratory, Miles City, MT
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Animal Diseases and Pests

A new vaccine against brucellosis in cattle may also protect bison against the contagious disease. Bison and elk are the last major sources of cattle brucellosis in the United States. Brucellosis is caused by the bacterium *Brucella abortus* and costs U.S. beef and dairy farmers about \$30 million annually. In an experimental study, ARS researchers vaccinated 10 bison female calves with the new vaccine, *B. abortus* strain RB51. The vaccinated animals' immune response was comparable to that of cattle vaccinated with RB51. Another plus: None of the RB51-vaccinated animals shed the live bacterium into the environment. This is important to protect other wildlife--moose, for instance, which could die if infected with the bacterium. USDA's Animal and Plant Health Inspection Service (APHIS) conditionally approved the new vaccine for use in cattle based on ARS studies demonstrating that RB51 protects cattle against brucellosis but doesn't give false signs of infection in blood tests of vaccinated cattle. ARS and APHIS staff are monitoring bison in Yellowstone National Park to determine how brucellosis is transmitted among free-living bison and elk. *National Animal Disease Center, Ames, IA*
Steven C. Olsen, (515) 239-8393

Honey bees fare better against deadly varroa mites if the bees build smaller versions of the six-sided cubbyholes, called cells, in which they rear their young and store honey. Beekeepers pre-determine the cell size bees will make by giving them wax sheets with base cells imprinted on them. From these "starter kits," the bees build layers of cells to make the honeycomb. But ARS scientists learned that when bees built combs from starter kits with a smaller cell size, those bees infested with the mites had a much higher survival rate--40 percent instead of near zero with the standard size cells. Researchers suspect the smaller cells result in lower stress on the bees, increasing the bees' ability to withstand mite infestations. Some beekeepers have lost half their hives to mites in recent years. Honey bees annually pollinate U.S. crops worth \$10 billion.

Carl Hayden Bee Research Laboratory, Tucson, AZ
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Corn treated with ivermectin could prove the solution to cattle tick woes on south Texas ranches. Even when cattle aren't present, tick populations can survive in an area by living on white-tailed deer. In a cooperative

study, researchers with ARS and USDA's Animal and Plant Health Inspection Service temporarily removed all cattle from the Caterina Ranch north of Laredo, Texas, where problems with cattle fever ticks have persisted for 50 years. Then the researchers provided ivermectin-treated whole kernel corn to white-tailed deer at feeding stations scattered across 22,000 acres. When all livestock on the ranch were returned and inspected in March 1997, no cattle fever ticks were found. This is the first time the area has been completely free of cattle fever ticks. Ivermectin is used to control several parasites in livestock and botflies on reindeer.

U.S. Livestock Insects Research Lab, Kerrville, TX
John E. George, (210) 792-0338

Soil, Water and Air

With the pull of a string-operated weed whacker, corn and soybean farmers can save surface water from possible chemical contamination and cut crop production costs, too. ARS studies of the Goodwater Creek watershed in Missouri indicate runaway herbicides are more likely to wind up in surface water rather than groundwater. But farmers can slash their herbicide use--and expense--by applying the chemicals only in a narrow strip over the crop row, then using a weed whacker to mow weeds between rows of corn or soybeans, the researchers say. Four years of ARS field tests showed this technique reduced herbicide use by 60 percent, while producing crop yields equivalent to those from weed-free fields.

Cropping Systems and Water Quality Research,
Columbia, MO
William W. Donald, (573) 882-6404

Trickle-L, an ARS-created Internet discussion group on drip irrigation, now links about 500 scientists, farmers, golf course managers, irrigation equipment manufacturers and others in the U.S. and abroad. Drip irrigation, also known as trickle or micro-irrigation, uses tiny sprayers or emitters to deliver precise amounts of water to plants. This can boost yields and reduce leaching of fertilizer and other chemicals into underground water. Since its launching three years ago, Trickle-L has become a convenient source of up-to-the-minute information and ideas on drip irrigation. Topics range from how to keep gophers from gnawing buried irrigation lines to the best irrigation techniques for asparagus and raspberries. Drip irrigation also can help home gardeners lower their water bills, the scientists say.

Another plus: It helps avoid excessive watering that might damage homes, fences and other structures.

*Water Management Research Laboratory, Fresno, CA
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The first measurements of greenhouse gas emissions from holding ponds for livestock waste shows they can emit from 36 to 268 pounds of methane per acre (40 to 300 kilograms per hectare) a day, depending on factors such as time of day, water temperature and wind speed. The measurements will help adjust global change prediction models. They will also enable the development of farming practices that lessen emissions or their impact. For example, 268 pounds of methane per acre is enough to fuel electricity generation. Scientists measured the emissions last summer with an array of "sniff tubes" mounted on a barge in the ponds, called animal waste lagoons. Samples of methane, nitrous oxide and ammonia were automatically drawn from the tubes for analysis by laser spectrometers. So far, nitrous oxide emissions have not been detected over the lagoons, although similar equipment did pick up emissions over farmland. Methane and nitrous oxide are greenhouse gases that could cause global warming. Ammonia emissions may contribute to soil acidification and can redistribute nitrogen to other areas where it may be unwanted. Ammonia emissions ranged from very low to a high of more than 54 pounds per acre (60 kilograms per hectare) a day.

*Southern Piedmont Conservation Research Center,
Watkinsville, GA*

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Machine-made channels in plowed fields may be moving more farm chemicals into groundwater than wormholes, rootholes and other natural channels prevalent in unplowed soils. Water with a chemical tracer and food coloring dye added was recently applied to plowed and unplowed fields. After excavating four 65-square-foot pits, ARS scientists photographed the stained flow pathways and then digitized the photograph for computer analysis. The analysis showed that "preferential flow" pathways are common in both plowed and unplowed fields. These pathways can move farm chemicals into groundwater much faster than normally expected. Analysis of the dye patterns revealed that the unplowed field had more biological byproducts from the breakdown of atrazine, a common herbicide, than the

tilled field. ARS scientists now believe that organic matter in the natural channels of the unplowed fields promotes growth of high numbers of microbes in the soil. These microbes, in turn, can help break down chemicals. In comparison, the machine-made pathways lack the organic material and perhaps the microbial populations to degrade farm chemicals. Scientists are now attempting to link these dye patterns to movement of nitrate from nitrogen fertilizer. As for herbicides and other farm chemicals, any movement of nitrate away from plant roots results in an economic loss to the farmer and poses a potential environmental risk to groundwater quality.

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Industrial (Non-Food) Products

A procedure known as high-volume instrumentation is the cotton industry's standard tool for determining the length, strength and natural color of cotton.

Adding another process--called near-infrared spectroscopy (NIR)--can also reveal bulk maturity, a characteristic that's key to how well the cotton will take dye. Dye imperfections cost the U.S. cotton industry approximately \$200 million annually. NIR uses light wavelengths that the human eye can't see to detect otherwise invisible fiber qualities. NIR failed to win industry acceptance in the past because of shortcomings in speed and accuracy. Now researchers have improved the mechanical design. One improvement: The new system uses a larger cotton sample pressed against a bigger glass plate, where the light waves shoot through the fiber. The bigger sample helps reduce measurement errors. Also, the mathematical equations used to analyze the NIR readings have been fine-tuned. In tests, the improved NIR analysis showed less than two percent error in its ability to predict cotton maturity.

*Southern Regional Research Center, New Orleans, LA
Joe Montalvo, (504) 286-4249*

Computer Systems and Models

A new, computerized guide to the botanical haunts of the Mediterranean fruit fly can help agriculture inspectors in the U.S. and abroad keep the troublesome insect out of a country. Medfly is one of the world's costliest agricultural pests. It reportedly attacks some 350 plant species. Because these plants are

known as "host" species, scientists dubbed the computerized database MEDHOST. It is the most extensive, up-to-date compilation available of medfly host plants reported in the scientific literature. Ag inspectors at airports and shipping docks can refer to MEDHOST when deciding whether plants being transported in luggage or freight should be held for further scrutiny. Researchers who need to know more about medfly's preferences can check MEDHOST's handy list of references to laboratory and field data. The database is available for use on computers with IBM-compatible operating systems.

*Tropical Fruit, Vegetable, and Ornamental Crop
Research Laboratory, Hilo, Hawaii*

Nicanor J. Liquido, (808) 959-4344, liquido@aloha.net

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Quarterly Report

of Selected Research Projects July 1 to September 30, 1997

United States
Department of
Agriculture
Agricultural
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Into the Marketplace

Cooperative Research and Development Agreements

...To Genespan Corp., Redmond, WA, to commercialize ARS-patented technology using a cell line derived from pig embryonic stem cells. ARS-PICM-19 is the first established liver-stem cell line and is able to regenerate fetal liver tissue in vitro. This phenomenon, observable within a culture dish, allows scientists to study liver biology. The ARS scientist developed this cell line as part of studies aimed at learning

how to modify pigs to grow faster and leaner. Continuous regeneration of normal liver cells in culture has been previously unsuccessful. This technology may be useful in making artificial liver devices and toxicological assay kits for detecting liver problems. (PATENT 5,532,156)
ARS Contact: Neil C. Talbot, Gene Evaluation and Mapping Lab, Beltsville, MD, (301) 504-8216, ntalbot@ggpl.arsusda.gov

...With Fruits International, Inc. of Coto Laurel, Puerto Rico, to develop a hot water immersion quarantine treatment for Puerto Rican mangoes. The treatment would allow mangoes weighing more than 700 grams (1-1/2 pounds) to be shipped to the U.S. mainland without risk of letting in the West Indian fruit fly. This fly is a major agricultural pest in Puerto Rico but is not established in the continental United States, Hawaii, or Japan—major mango markets. Quarantine treatments must be 100 percent effective in controlling eggs and larvae of the pest. In an experimental treatment for mangoes weighing 1-1/2 to 2 pounds, the fruit is immersed in 115- to 116-degree F. water for 45 to 180 minutes. Then it is cooled and evaluated for market quality. For lighter mangoes, ARS already developed a treatment approved by USDA's Animal and Plant Health Inspection Service. Mango demand in the United States has steadily increased. Imports jumped from 59 million tons in 1993 to 93 million tons—worth more than \$69 million—in 1996.
ARS Contact: Jennifer Sharp, Subtropical Horticulture Research Station, Miami, FL, (305) 238-9321, miajs@ars-grin.gov

Licenses

...To International Diagnostic Systems (IDS), St. Joseph, MI, to make fast, inexpensive test kits to detect the antibiotic hygromycin B in animal feed. Hygromycin B is added to livestock and poultry feed to protect pigs and chickens against disease, but its presence in feed is regulated by the U.S. Food and Drug

Contact the scientists listed for further information on each research project. For general questions about this report, contact Hank Becker, ARS Information, 6303 Ivy Lane, 4th Floor, Greenbelt, MD 20770, (301) 344-2769, hbecker@asrr.arsusda.gov

Items marked with the word PATENT are being patented by ARS. For more information on patents, CRADAs and patent licenses, contact ARS Office of Technology Transfer, Bldg. 005, Rm. 416, BARC-West, Beltsville, MD 20705, (301) 504-5734. Questions about a company's product and/or research should be directed to the company itself.

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Administration. Feed mills are required to periodically test medicated animal feeds to ensure they contain the appropriate levels of hygromycin B. To make the test kit, IDS uses an ARS-developed and -patented antibody. The new kit replaces traditional analytical methods, which require expensive equipment and chemical solvents. Lab technicians can perform the new test in less time and without equipment clean-up, maintenance, or solvents. One major company currently evaluating the use of the IDS test kits is Eli Lilly's Elanco Division in Indianapolis, IN.

ARS Contact: Larry H. Stanker, Food and Animal Protection Research Lab, College Station, TX, (409) 260-9484, stanker@usda.tamu.edu

...To Florida Sun Citrus, Inc., Jacksonville, FL, and Fresh Cut Fruits, Inc., Columbia, MD, to use an ARS-patented process to peel citrus with natural enzymes. This technique uses commercially available food-grade enzymes to dissolve albedo, the white, pithy material that keeps citrus peel clinging to the fruit. The process allows fruit to be peeled without losing any juice or separating the citrus sections. Another advantage: whole fruit that, because of peel defects, wouldn't make the grade for the fresh market can be pre-peeled and still used for fresh consumption. (PATENT 4,284,651)

ARS Contact: Robert A. Baker, U.S. Citrus and Subtropical Products Research Lab, Winter Haven, FL, (941) 293-4133, ext. 120, rabaker1@concentric.net

Patents

Economical, commercial mass-rearing of millions of helpful predatory bugs to control crop pests may be possible as early as next year. Lack of economical and suitable artificial diets has limited the use of predators as an alternative to pesticides. But ARS scientists developed and now are patenting new diets for lab-reared big-eyed bugs and lacewings. These two insects devour a wide range of pests including whiteflies, aphids, scale insects, and mealybugs. They also eat eggs and larvae of many moth pests like the tobacco budworm, pink bollworm, and corn earworm. Among the main ingredients in the new diets are ground beef, beef liver, and cooked whole eggs. Fish innards, oysters, and meat and liver from other animals might be substituted. The new lacewing diet costs only \$2.50 a pound. A commercial diet of insect eggs can cost \$300 a pound. Lacewings and big-eyed bugs reared on the new diets produce more offspring, often mature

faster, and are up to 50 percent larger than wild ones, according to the scientists' studies. With slight modification, the diets work for other predators including a lady beetle and a minute pirate bug. (PATENT APPLICATION 08/699,815).

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Biocontrol and Mass-Rearing Research, Mississippi State, MS

*Allen C. Cohen, phone (601) 323-2230,
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ARS scientists have patented a sex attractant to foil the mating of cranberry fruitworms. The fruitworm, *Acrobasis vaccinii* Riley, is the most destructive insect of cranberries in the United States and Canada. It sometimes wipes out entire crops. Scientists found two compounds that, mixed in the right ratio, strongly attract hopeful males by mimicking the female's mating pheromone. The mixture could be used to bait traps that will snare the pests, preventing them from mating as well as giving growers a simple way to monitor the cranberry bog for the pests' presence. This could give growers a way to eliminate unnecessary insecticide use. Instead, they could wait until enough pests are trapped to indicate the crop is seriously threatened. (PATENT 5,607,670).

*Fruit and Vegetable Research Lab, Wapato, WA
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A nondestructive diagnostic test for citrus blight uses proteins found in leaves of affected plants. The new test was developed and patented by ARS. The cause of citrus blight is unknown, and there is no known cure. Current methods of detecting this stealthy disease—which only shows symptoms when it's too late to control—are inadequate. Repeated tree testing, by boring or cutting, can expose trees to the risk of further infections. An ARS scientist isolated and identified a gene responsible for one of the proteins. Scientists use peptide epitopes, which come from the diseased plant tissues, to make monoclonal antibodies. These molecules signal the blight's presence. A world-wide problem, citrus blight costs Florida citrus growers about \$52 million a year, including tree value and replacement costs. Once symptoms appear, the tree gradually dies. But the newly patented test allows detection before symptoms appear. This not only might save trees but also could help scientists find the cause and

a cure. (PATENT 5,650,151)
U.S. Horticultural Research Lab, Orlando, FL
Michael G. Bausher (407) 897-7300,
mbausher@magicnet.net

Insect resistance and other traits boasted by potato's wild relatives might soon be easier to breed into commercial varieties. Today, when wild potatoes are bred with commercial types, offspring sometimes inherit an unwanted trait from the wild parent—high levels of bitter-tasting toxins called glycoalkaloids. High-glycoalkaloid potatoes won't pass safety tests. But ARS researchers discovered and short-circuited a gene responsible for making an enzyme that potatoes use to make alpha-chaconine, a key glycoalkaloid. The enzyme is known as solanidine UDP-glucose glucosyltransferase. Experimental plants with the "rebuilt" gene had lower glycoalkaloid levels, according to lab and greenhouse tests in California. ARS scientists in Idaho harvested more tubers with the altered gene this fall. They'll look not only at the potatoes' glycoalkaloid levels, but also for desirable attributes like resistance to insects and diseases. Potato breeding programs seek the perfect potato for fresh-market sale or for processing into chips, french fries, dehydrated flakes, or other popular potato products. (PATENT APPLICATION 08/797,226)

Crop Improvement and Utilization Research, Western Regional Research Center, Albany, CA
William R. Belknap, (510) 559-6072, wrb@pw.usda.gov

An environmentally friendly microbe may help protect tomorrow's freshly harvested fruits from organisms that cause costly rotting. ARS and Texas A & M University researchers have discovered a helpful strain of the well-known microbe that causes sour rot. The beneficial strain is called *Geotrichum candidum* strain AVIR. In lab tests with grapefruit and oranges, those treated with the beneficial strain had a lower incidence of attack by green mold. Applied as a dip or spray, the helpful microbe might reduce reliance on fungicides to protect citrus. Researchers think it might also protect apples, pears, and strawberries from their worst microbial enemies. (PATENT 5,668,008)
Horticultural Crops Research Lab, Fresno, CA
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Tomorrow's growers may save water and reduce chemical leaching into groundwater with an

experimental variable-flow sprinkler head. Engineers from ARS, the University of Idaho, and Precision Irrigation Systems, Inc., of Soda Springs, ID, designed the device. It can reduce nozzle flow by nearly 35 percent of full capacity without additional wear and tear on the irrigation system. Flow volume is adjusted to accommodate natural features such as slope or soil type. As it moves through a field, a computer-controlled overhead sprinkler system equipped with the new nozzles would apply water on sandy, fast-draining areas at a rate different from that on heavy, slow-draining clay soils. Engineers expect the device to cost less than other options requiring more pressure regulators, wiring, and plumbing. (PATENT APPLICATION 08/650,295)

Northwest Irrigation and Soils Research Lab, Kimberly, ID

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Plant Genetic Resources

Eight new wheat germplasm lines offer resistance to the Hessian fly—even though all the new lines were developed in part from a commercial hard red winter wheat called Newton that's susceptible to Hessian fly attacks. Scientists with ARS and Purdue University developed the new resistant lines by transferring eight different genes for Hessian fly resistance individually into Newton. In seeding tests, the lines proved resistant to one or more of four Hessian fly biotypes. All of the lines are similar to Newton, but can be up to 4 days later in heading and from 4 inches shorter to 3 inches taller than Newton. The new lines—Carol, Erin, Flynn, Iris, Joy, Karen, Lola and Molly—have adequate winter hardiness for testing in many areas of the United States and for determining the value of the individual genes in providing resistance to local populations of the Hessian fly. The lines also provide genes for use in breeding resistant cultivars and genetic studies. Seed can be obtained now from Purdue University and next year through the ARS National Small Grains Collection, Aberdeen, ID.

Crop Production and Pest Control Research, West Lafayette, IN
Roger Ratcliffe, (317) 494-4606,
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An improved linden viburnum called 'Catskill' offers gardeners a colorful, slow-growing shrub ideal for limited space. Developed by ARS scientists from seed

obtained in Japan, *Viburnum dilatatum* 'Catskill' takes about 15 years to reach a height of 5 feet and an 8-foot spread. Covered with small, creamy-white flowers in mid-May, it has small round leaves that are dark green throughout summer and turn yellow, orange, and red in autumn. 'Catskill's' dark red berries persist until mid-winter. The shrub is easy to grow and well adapted to USDA Plant Hardiness Zones 5b to 8. It grows best in a moist, slightly acid soil. Planting in full sun will produce more flowering and fruiting, but in hotter areas of Zone 8, 'Catskill' should be planted in partial shade. It is available commercially. The U.S. National Arboretum has one of the world's few viburnum breeding programs. *Floral and Nursery Plants Research, U.S. National Arboretum, Washington, D.C.*
Ruth L. Dix, (202) 245-4762, rdix@asrr.arsusda.gov

Six dry bean germplasm lines representing new sources of resistance to white mold have been released by ARS and university scientists. White mold, the most economically important dry bean disease in the United States, causes more than \$50 million in annual yield loss. Fungicides that cost from \$10 to \$15 per acre provide only partial control of the disease, but still are applied to an estimated 300,000 acres each year. The new lines—I9365-1, I9365-3, I9365-5, I9365-19, I9365-31 and 92BG-7—were developed at the Tropical Agriculture Research Station in Mayaguez, PR, with cooperation from breeders and plant pathologists in Colorado, Michigan, Nebraska, and North Dakota. They have high yield potential in both tropical and temperate environments. All six lines have various combinations and levels of resistance to common bacterial blight, rust, bean common mosaic virus, Fusarium wilt, Fusarium root rot, and ashy stem blight, as well as white mold. A limited quantity of seed from these lines is available for research and variety development. New varieties are expected to be available in about 5 years.

Vegetable and Forage Crop Production, Prosser, WA
Phillip Miklas, (509) 786-9258,
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Plump, sweet Autumn Royal grapes should give shoppers a new and delicious dark grape for late fall and early winter. The large, oval-shaped Autumn Royal berries have purple-black skin with a whitish bloom. Inside, the firm, crisp flesh is an attractive, translucent green-yellow. Vines ripen in the first half of October, but fruit can be marketed into December because Autumn

Royal stores so well. ARS researchers put Autumn Royal through approximately a decade of vineyard analysis and laboratory tests. The scientists made cuttings available to growers, and the new variety is showing up in markets. Autumn Royal is the newest grape from the ARS laboratory that also launched Flame Seedless, America's favorite red seedless grape.

Horticultural Crops Research Lab, Fresno, CA
David W. Ramming, (209) 453-3061, drammm@qnlis.net

A "royal family" of June peaches and nectarines from ARS offers flavorful and vigorous new alternatives to growers in the Southeast. The new fruits are Rubyprince and Southern Pearl peaches and Juneprincess and Blazeprince nectarines. All measure 2 to 3 inches in diameter. Rubyprince, a firm but good textured and flavored peach, is adapted to the Southeast and ripens in early June. It has moderate resistance to bacterial spot, as does Southern Pearl. Southern Pearl, a firm, white-fleshed peach with good eating qualities, ripens in mid-June. The princess of nectarines, Juneprincess, is a more reliable producer and less susceptible to cracking and brown rot than other mid-June nectarines. Juneprincess has yellow flesh and good texture and flavor. Blazeprince peach ripens in late June. The fruit has yellow flesh and hangs well on the tree when approaching maturity, an advantage for harvesting. A limited number of trees of the new varieties will be available from nurseries in Tennessee this winter. Virus-indexed budwood is available from the IR-2 program in Prosser, WA. Small amounts of nonindexed wood are available from W.R. Okie.

Fruit and Tree Nut Research Lab, Byron, GA
William R. Okie, (912) 956-6405, a03dokie@attmail.com

Two new nectarines from ARS breeders in California make a healthful, low-calorie snack or tasty addition to salads or desserts. Crimson Baby nectarine has flavorful yellow flesh. Its smooth yellow skin is nearly covered by a red blush dusted with light-colored speckles. An early-season variety, Crimson Baby is ready to harvest about the last week of May. It resulted from embryo rescue, a laboratory technique that extracts undersized embryos from pits and grows them in nutrient gel to become viable seedlings. These tiny embryos typically result from crossing early season parents and usually would not survive without the rescue technique. Crimson Baby trees yield large, round fruit, about 2-1/2 inches in diameter. September Free nectarine, harvest-ready in late August to early September, is a firm, top-quality freestone. Most

other commercial nectarines that ripen at that time are clingstones, with flesh that clings stubbornly to the pit. For eating out-of-hand or slicing, most people prefer freestone fruit, with flesh that releases easily from the stone. Scientists have already made cuttings of both nectarine varieties available to growers; fruit might be in the marketplace in about 5 years.

Horticultural Crops Research Lab, Fresno, CA

David W. Ramming, (209) 453-3061, dramm@qnis.net

Grant, a new soft winter wheat, offers high yields, improved disease resistance and better cold-weather hardiness. Grant also has improved resistance to Hessian flies, among the worst wheat pests in this country. Developed by ARS scientists in cooperation with Purdue University, Grant performed well in test plots across Indiana, Illinois, Missouri, and Ohio. Grant is a cross of the Caldwell, Beau, and Kavkaz wheat lines. Kavkaz provided Grant's resistance to leaf rust and powdery mildew. Kavkaz and Beau supplied increased kernel size, and Caldwell contributed milling and baking qualities and early maturity. In 8 years of testing, Grant outyielded Caldwell by 4,630 pounds per acre. It starts grain formation 1 to 2 days later and has shorter, stronger straw. In addition to leaf rust and powdery mildew, Grant resists wheat soilborne mosaic, wheat spindle streak mosaic and take-all diseases.

Crop Production and Pest Control Research, West Lafayette, IN

Roger H. Ratcliffe, (756) 494-4606, roger-ratcliffe@entm.purdue.edu

Blush and Burgundy, two new Chinese witch hazels that feature bright pink flowers, are now available at garden centers. These medium-size, low-growing, shade-loving evergreen shrubs are ideally suited for the home landscape. ARS scientists selected the new varieties from germplasm they obtained from nurseries in Japan. The shrubs reach about 5 five feet in height and width within 5 years. They can be sheared to form hedges or retrained as small trees reaching heights of 10 feet. Flowering in late winter to early spring, both shrubs are selections of *Loropetalum chinense*, a southern witch hazel. The species generally has creamy white to light green flowers and dark green leaves. Blush, however, has clusters of red-purple flowers, while Burgundy's flowers match its name. Young leaves are rose-colored on Blush; they mature to an olive green. Burgundy's young leaves are dark red and mature to yellow-green. Both grow best in

well drained, loamy, slightly acid soils in USDA Plant Hardiness Zones 7 to 9. They are largely free of insects and disease pests.

U.S. National Arboretum, Washington, D.C.

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Plant breeders can now use six new germplasm lines of guayule to improve this native U.S. rubber-producing crop. Guayule, a perennial plant, could provide additional income for farmers in the arid and semiarid Southwest. ARS scientists selected the new lines for high yield and uniformity, two important traits that current varieties lack. The six guayule lines (named AZ-1 through AZ-6) are from earlier selections by University of Arizona researchers. Each conveys important traits. At 2 years old, for example, AZ-2 is twice the size of some current varieties when they are 3 years old. Others of the new lines yield twice as much guayule rubber as older varieties. Guayule has the potential to become a domestic source of natural rubber, for which there is ever-increasing demand. In addition, earlier studies by ARS in collaboration with medical researchers have shown that guayule latex does not contain allergenic proteins known to be in latex from the tropical *Hevea* rubber plant.

U.S. Water Conservation Lab, Phoenix, AZ

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Human Nutrition

If older Americans consumed extra vitamin D along with extra calcium, it might substantially reduce the enormous cost of treating broken bones in the elderly—estimated to be \$13.8 billion in 1995. That's the finding of a 3-year study of 389 men and women over age 65. The group that took calcium and vitamin D supplements daily had less than half as many broken bones during the course of the study as the group that got a placebo—11 fractures versus 26. The supplements contained 500 milligrams of calcium and 700 International Units (IU) of vitamin D. This substantial reduction in fractures can't be explained by the small changes in bone mineral density between the two groups, the researchers said. By the end of the study, the supplemented group was only slightly ahead of the placebo group in bone mineral density, according to total body measurements and measurements of the hip and spine. The study is the first to demonstrate that extra calcium and vitamin D can

reduce the effect of osteoporosis in men. During the study, participants consumed a little more than 700 mg of calcium daily from their diets. That's at the high end of the typical intake for men and women over 65, which falls between 500 and 700 mg. By adding the supplements, they averaged close to the 1,200 mg now recommended for people age 51 and over. To get that amount from foods, a person would need to consume a well-balanced diet, including three sources of dairy products daily.

Jean Mayer USDA Human Nutrition Research Center on Aging at Tufts, Boston, MA

Bess Dawson-Hughes or Susan S. Harris, (617) 556-3064/3073; hughesb@hnrc.tufts.edu; harris_si@hnrc.tufts.edu.

Findings from a new study support the U.S. government recommendation that pregnant women should limit supplemental iron to 30 milligrams per day unless they have iron-deficiency anemia. Researchers from the University of California at Berkeley, California Public Health Foundation, and ARS collaborated in the 15-month study with 13 volunteers. The study monitored zinc absorption rates before and after pregnancy. Results suggest that nursing mothers who take high doses of iron might interfere with their body's ability to absorb zinc. Scientists already know from animal and human studies that the body's ability to absorb zinc changes dramatically during and after pregnancy. The new study was the first to document the changes at intervals from pre-conception to about 2 months after birth. It also was the first, in humans, to suggest iron supplements might interfere with zinc absorption during lactation. Pregnant women need zinc for normal fetal growth and development. After their babies are born, the mother needs zinc for producing breast milk. Severe zinc shortages can retard growth, impair brain function and reduce the body's ability to fight infection. Many women do not consume the recommended daily intake during pregnancy (15 mg) or lactation (19 mg). The richest food sources include red meat, liver, oysters, beans, whole grains, garbanzo beans, and poultry.

Western Human Nutrition Research Center, San Francisco, CA
Janet C. King, (415) 556-9697, jking@whnrc.usda.gov

Protein-rich foods don't prompt the loss of body calcium through the urine, in contrast to what some health professionals have believed. A new ARS study--along with two other studies--finds no support for the notion that diets containing ample meat, fish and

poultry increase the risk of osteoporosis. In the ARS study, 14 postmenopausal women excreted no more calcium when eating 10 ounces of meat, fish, or poultry daily for 7 weeks than when eating only 1-1/2 ounces of these high-protein foods. Researchers attribute this to the phosphorus in these foods, which appears to save calcium. The belief that high-protein foods increase calcium loss came from earlier studies in which people consumed pure protein, which does not contain phosphorus or other nutrients that may counterbalance the protein's effects, say the researchers. The latest findings have an important implication for elderly people, especially those with osteoporosis: They shouldn't limit their intake of protein-rich foods for fear of this disease. In fact, low serum protein has been associated with an increased risk of hip fractures. Many elderly consume too little protein and could benefit from regularly consuming moderate amounts of lean meat, poultry, or fish.

Grand Forks Human Nutrition Research Center, Grand Forks, ND

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High amounts of a natural cancer-fighting compound have been found in Tribute and Delite, strawberry varieties developed by ARS scientists. In an evaluation of 36 strawberry varieties, these two had the highest levels of the compound, ellagic acid. The acid content varies by variety, and the researchers found more of it in the leaves than in the seeds or fruit pulp. Now they can breed for higher levels in the fruit, where it is most needed. Researchers don't yet know how much ellagic acid must be consumed to produce beneficial effects. But studies with the National Cancer Institute and Ohio State's Department of Preventive Medicine suggest that a diet that includes strawberries, raspberries, blackberries, cranberries, walnuts and pecans would be rich in ellagic acid.

Fruit Lab, Beltsville, MD
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Cutting calories may inadvertently slow dieters' reaction times. This effect may continue for weeks after the diet ends, ARS researchers and their British colleagues report. Reaction time lengthened 11 percent in the 14 women volunteers who went on a reducing diet. What's more, reaction time continued to grow for 3 weeks after the diet ended. Scientists want to know if the slowdown lowers dieters' alertness--and thus increases the risk of accidents. They also want to learn if the longer diet

regimens sometimes needed to achieve healthful weights might increase this risk. Further study of dieting's effects on reaction time could lead to new understanding of how the body uses calories and nutrients for thought and action. Healthcare professionals could use this information to improve diet and exercise plans for overweight Americans. The new study confirms an earlier finding by the British investigators, who are with the British Biotechnology Sciences Research Council. Scientists measured reaction time at five intervals during the study by determining how long it took the women to hit the space bar on a computer keyboard when a white star appeared on the screen. The overweight but healthy volunteers, age 25 to 42, lost an average of 27 pounds during the 21-week study. For most of this time, they ate only half of the number of calories needed to maintain their beginning weight.

Western Human Nutrition Research Center, San Francisco, CA

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Chromium supplements—in two different formulations—lowered blood pressure in rats bred to spontaneously develop hypertension. The supplements, chromium picolinate and chromium nicotinate, also reduced the formation of damaging free radicals in the animals' tissues, indicating that chromium can act as an antioxidant. The findings confirm and expand on those of an earlier collaborative study between Georgetown University and ARS scientists. In the earlier study, chromium nicotinate lowered blood pressure in the rats after researchers exaggerated hypertension by adding table sugar to their drinking water. In the latest study, the Georgetown University and ARS researchers tested four other chromium formulations and found that three—chloride, acetate and picolinate—also significantly lowered the rats' blood pressure. Earlier human studies have linked hypertension with diabetes and with insulin resistance—the inability of insulin to get glucose into cells. Chromium is essential for insulin to operate efficiently and has been shown to reduce diabetic symptoms and restore glucose tolerance in studies of humans and animals. Two of the chromium formulations, picolinate and nicotinate, reduced blood sugar. That's according to the animals' hemoglobin A1C levels—the most sensitive measure of blood sugar. What's more, both compounds reduced the formation of free radicals in the animals' livers, based on measurements of highly reactive

free radicals. The nicotinate formulation was also protective in their kidneys. Free radicals form naturally in cells and are counteracted by antioxidants.

Beltsville Human Nutrition Research Center, Beltsville, MD

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Georgetown University Medical Center, Washington, DC
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Boosting fiber intake can reduce the number of calories your body absorbs from the foods you eat. Results from a recent ARS study indicate that increasing fiber intake decreases digestion and absorption of both fat and protein. Based on actual measurements from the study, the scientists say that American men who double their daily fiber intake from an average 18 grams to 36 grams would absorb about 130 fewer calories per day. Women who increase fiber intake from 12 to 24 grams a day would absorb about 90 fewer calories. The researchers tested nine diets on 17 volunteers for 2 weeks at a time. The diets were combinations of low, medium, and high fat with low, medium, and high fiber. The researchers measured how much carbohydrate, fat, protein, fiber, and energy (calories) the volunteers' bodies used from each of the diets. More news on fiber and calories: The researchers say the calorie counts listed on labels for fiber-containing foods could be more accurate. Because some of the calories in foods don't get digested and absorbed, food manufacturers estimate the available calories in each product.

Beltsville Human Nutrition Research Center, Beltsville, MD

David J. Baer, (301) 504-8719, baer@bhnrc.arsusda.gov

There's good news for people concerned about the safety of taking chromium supplements. In a 20-week ARS study, rats that daily consumed more than 2,000 times the estimated safe limit of chromium for people showed no signs of toxicity. Researchers tested two widely used formulations of the mineral—chromium picolinate and chromium chloride. While neither produced toxicity, the animals stored more of the picolinate in their tissues, indicating that they absorbed more. The findings support earlier reports of very low toxicity in animals. And they bring into question the relevance of a study done 2 years ago using cultured human cells that reported DNA damage. Cultured cells are far more vulnerable than body cells because they lack the body's normal protective

mechanisms. People generally absorb less than 2 percent of the chromium in the diet. Years of ARS chromium studies with animals and people have not identified any toxic symptoms, even when chromium was given several times above the suggested daily upper limit of 200 micrograms. In fact, the highest daily exposure considered safe over the course of a lifetime is 350 times this upper limit. This reference dose was established by the Environmental Protection Agency.

Beltsville Human Nutrition Research Center, Beltsville, MD

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A post-harvest vapor heat treatment keeps leaves of kale and collards from yellowing and reduces their loss of sugar and other nutrients in storage. Leafy green vegetables—rich sources of important nutrients and dietary fiber—are highly perishable after harvest. In ARS lab tests, kale treated at 113 degrees F for 30 minutes remained green and crisp after 7 days in storage at 59 degrees F. Collards, more heat sensitive, maintained their freshness for a week at the same storage temperature when first held at 104 degrees F for 60 minutes. Scientists don't know how the heat protects the produce. But they do know that stress from heat promotes the build-up of certain proteins. These same "heat shock proteins" may also provide resistance to deterioration caused by cold storage, when produce later is stored at the lower temperatures. Further research is planned to answer these questions.
Horticultural Crops Quality Lab, Beltsville, MD
Chien Y. Wang, (301) 504-6128

IPM/Biological Control

A new ARS-developed Mediterranean fruit fly lure being tested in Florida may help keep this pest at bay by catching females before they can lay eggs. The female medfly, about the size of a housefly, can produce up to 800 eggs in her 30-day life span. So far, the pest has caused trouble in isolated outbreaks, but has not become endemic to the mainland United States. Until now, the only widely available traps use a male-targeted synthetic lure. ARS' new three-component lure uses ammonium acetate, putrescine, and trimethylamine. In the tests, 50 to 90 percent of the medflies captured in traps baited with the new lure were egg-laying females. The new lure has also proved less appealing to sterile male medflies than existing traps. That's an advantage in

programs—such as one this past summer in the Tampa, FL, area where the new lure is undergoing field tests—that release sterile male flies as a part of a medfly eradication program.

Center for Medical, Agricultural and Veterinary Entomology, Gainesville, FL

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Overhead water sprinklers in orchards can cut fruit injury from codling moths by 60 to 90 percent—a bonus just discovered by an ARS scientist. Apple growers in Washington use the sprinklers to cool fruit during hot spells. That improves fruit quality and color and reduces sunburn. Uncontrolled, codling moths can wipe out entire orchards. The ARS scientist noted that the water disrupted moth flight, egg laying, and egg and larvae survival from July to September. The down side: The water might leave unsightly mineral deposits on the apples and a slight reduction in fruit size if growers don't watch water quality. Using canal water or treating well water to lower acidity can minimize this damage.

Fruit and Vegetable Insect Research, Wapato, WA
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A harmless fungus and a touch of commercial fungicide knock out fungal pathogens that kill cotton seedlings. By using the beneficial fungus *Trichoderma virens*, ARS scientists say, growers can reduce reliance on chemical fungicides and still dramatically cut seedling losses. In a 3-year field study in California and across the southern Cotton Belt, the scientists coated cotton seeds with the harmless fungus and with the fungicide metalaxyl. The result: 85 percent of the seeds germinated into seedlings that survived even though the fields were infested with a variety of fungal disease pathogens that normally attack the seedlings. Without treatment, only 25 percent germinated. In 1995, cotton producers in six major cotton-producing states applied 719,000 pounds of fungicides to control seedling diseases. Seedling diseases that year caused \$1.9 million in losses in the U.S. cotton crop. Seedling disease pathogens include *Rhizoctonia solani*, *Pythium ultimum*, *Thielaviopsis basicola*, and *Fusarium solani*.

Southern Crops Research Lab, College Station, TX
*Charles R. Howell, (409) 260-9232,
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A new, portable insect sampler dubbed the "KISS"—for "keep-it-simple sampler"—helps farmers and crop consultants measure insect populations in cotton, soybeans, corn, and other row crops. Knowing how many pests are in the field can let growers know whether pesticide or other controls are needed. ARS researchers designed the KISS from an engine-driven leaf blower. It generates 150-mph winds that dislodge pests from crops and blow them into a net attached to the nozzle. Preliminary field tests indicate "KISSing" is 10 times more efficient than hand-collecting boll weevils in early-season cotton. Boll weevils cause \$330 million in cotton losses each year.

Areawide Pest Management Research, College Station, TX

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Mite feces are a dead give-away that honey bee hives are infested with a parasite that's causing devastating damage in some areas of the United States. Now, with a simple new field test developed by ARS, beekeepers can quickly determine if their hives are infested with varroa mites. Then they can act quickly to control them. Current tests for varroa mites are time-consuming and expensive, and may require pesticides. But ARS researchers found that even very low infestations of this pest can readily be detected by the brilliant white specks of its feces. Known as *Varroa jacobsoni*, varroa mites originated in Asia and were first found in the United States in 1987. They suck blood from immature bees, mainly those in the last pre-adult stage. During a 10- to 12-day feeding period, female adult mites and offspring defecate on the horizontal brood cell wall just above each developing bee. The white feces can easily be seen if a brood comb is removed and inverted under bright sunlight. Varroa and other mite species have destroyed 80 percent of commercial beehives in some areas of the United States in recent years.

Carl Hayden Bee Research Lab, Tucson, AZ

Eric H. Erickson, (520) 670-6481, ehejr@ccit.arizona.edu

A natural fungus can control sicklepod, a major weed in soybeans, cotton, and peanuts in the southern United States. ARS researchers formulated spores of the fungus, *Colletotrichum gloeosporioides*, into a spray mixture with corn oil and water. Two sprays killed 95 percent of newly emerged sicklepod weeds in soybean plots. More

than 3 years of field tests showed an overall sicklepod reduction of 90 percent. ARS has patented use of the fungus and stored samples of strain NRRL 21046 at the ARS Culture Collection in Peoria, IL. ARS is seeking industry cooperators to develop the fungus commercially as a biological alternative to chemical herbicides. (PATENT 5,529,773)

Southern Weed Science Research, Delta States Research Center, Stoneville, MS

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Images of fungicide crystals scattered like snowflakes across a plant leaf can now be made using new technology developed by ARS scientists. The technology—dubbed Electron Beam Analysis (EBA)—combines scanning electron microscopy, X-ray micro-analysis, and digital imaging to produce 100,000-times-larger-than-normal images of pesticides. Each chemical has its own unique shape and chemistry, so scientists can check plant leaves to see which product was used, where it landed on the leaf, and how much of the leaf surface was covered. Digital images are scanned into and stored in a computer for future reference. This information can help scientists pinpoint the most effective control agents and improve recommendations for reducing pesticide usage in food and field crops.

Application Technology Research Lab, Wooster, Ohio

Charles R. Krause, (330) 263-3672, krause.2@osu.edu

A new lab diet is in the works for producing parasitic wasps that can help U.S. growers biologically control the Colorado potato beetle and reduce the use of chemical insecticide. Each year, this beetle costs U.S. eggplant, tomato, and potato growers an estimated \$150 million in losses and insecticide-related expenses. A promising natural weapon against the beetles: Female *Edovum puttleri* wasps that lay their eggs inside the beetle's eggs, preventing the pest from hatching and becoming a wormlike larva that feeds on plants. But the wasps, native to South America, need a helping hand from science if they are to become widely available biocontrols in the United States. Using real beetle eggs to lab-rear millions of wasps would be prohibitively expensive. ARS researchers have devised an artificial diet that mimics the beetle egg's yolk-like contents. The chief ingredients are chicken egg yolk, powdered milk, and insect blood called "hemolymph." The researchers also developed artificial "beetle eggshells," a parafilm plastic membrane that contains enough diet to nourish a wasp larva until it's

ready to emerge as an adult. Releasing adult wasps to attack real beetle eggs in crop fields wouldn't completely eliminate the need for insecticide. But growers could cut the number of sprayings. The scientists' goal is to make the commercial cost of lab-rearing *Edovum* affordable to insectaries that would sell the wasps to farmers.

Insect Biocontrol Lab, Beltsville, MD

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A Brazilian fly that attacks fire ants could be part of a new, environmentally friendly strategy to control the pests. Fireants infest millions of acres in the southern United States. ARS scientists made the first outdoor releases of the predatory flies, called phorid flies, in Florida in July. The flies zero in on a fire ant and—in a split second—dive-bomb it, pierce its outer cuticle, and deposit an egg inside the pest. The egg develops into a larva that migrates into the ant's head. Although the ant's head soon falls off, the young fly continues to mature inside it. Phorid flies attacks only fire ants and pose no threat to other insects, wildlife, or humans. The Florida releases of phorid flies followed quarantine studies dating to 1994. ARS scientists also are examining other potential biological controls for fire ants. Among the candidates: *Thelohania solenopsae*, a microbe that infects fire ants with a slow-acting disease that eventually destroys the ant colony, and *Solenopsis daguerrei*, a parasitic ant that invades the ant colony, attaches itself to the queen and eventually starves her.

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Crop Productivity

Giving pecan orchards a different landscape architecture—by hedge-type pruning—rejuvenates the trees and could increase profits, ARS researchers found. Four years of research indicate that hedged orchards and research plots avoid several disadvantages of traditional orchards. In the latter, large trees make poor use of space and light, and age-related physiology changes in the trees reduce overall yield. But hedge-style pruning can provide more uniform yields of high-quality nuts. The small, pruned trees tolerate more feeding by many types of

leaf-feeding insects without economic loss and require less insecticide use. They also exhibit higher photosynthetic rates than large trees. While there are many hedging options, indications are that orchards should probably be hedged on all four sides of the canopy on 2- or 4-year cycles. Canopies of individual trees should be about 20 feet wide and 30 feet tall with 30 feet between tree rows. Pecan orchards span the entire southern United States. *Southeastern Fruit and Tree Nut Research Lab, Byron, GA*

*Bruce W. Wood, (912) 956-6421,
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Early maturity and less boll rot: They're the latest reasons why okra-leaf cotton plants could help U.S. growers cut their production costs without sacrificing yields. In field studies, ARS scientists found okra-leaf types could be harvested 3 to 9 days earlier and often achieved the same yield as conventional types—a plus during early cold spells or extended wet periods. Cotton with this leaf type is also less prone to boll rot than conventional cotton types. The leaves are narrower and more evenly distributed on the plant than other cotton types. Okra-leaf cotton also resists attacks by whiteflies, pink bollworms, and other insects better than commonly grown varieties.

Cotton Physiology and Genetics Research, Stoneville, MS

James J. Heitholt, (601) 686-5219, jheithol@ag.gov

A new fiber optic sensor that detects soil smearing could help farmers boost corn yields. Smearing occurs when seed-planting equipment rubs against the soil, forming a smooth, compact layer in the seed furrow. Soil smearing in farm fields can make it tough for young corn plant roots to push their way through the soil. The new sensor is designed to warn growers that smearing is happening—allowing them to adjust equipment or change planting attachments.

National Soil Dynamics Lab, Auburn, AL

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A new ARS-developed formula to predict cotton moisture could help cotton ginner operators operate more efficiently. If ginner operators try to process cotton that's too wet—more than 7 percent moisture—the damp fibers can clog their machinery. But too much drying damages the delicate fibers and wastes energy. The new mathematical

formula lets ginners more accurately calculate cotton moisture based on air temperature, air flow, and how much cotton is coming through the line. The ginners can then fine-tune their drying systems for optimum processing. The formula looks promising for use on cotton with moisture content of 6 to 20 percent and will be tested in a commercial gin during the 1997-98 ginning season.

Southwestern Cotton Ginning Research Lab, Mesilla Park, NM

Marvis N. Gillum, (505) 526-6381

Crop Diseases and Pests

Head scab fungus, *Fusarium graminearum*, the bane of wheat crops, can be genetically disarmed. ARS scientists identified and deleted the genetic codes for an enzyme that the fungus needs to produce the toxins trichothecene. The fungus uses this toxin to infect cereal crops. Head scab steals the plant's energy, cutting its yield, and produces toxins which contaminate the grain. Head scab, which causes billions of dollars in losses each year, gets its name because it looks like scabs on the infected plant. Infections are cyclical, appearing for several years and then disappearing. However, the Midwest is currently experiencing a sustained infestation of head scab. The fungus mutates frequently, thwarting plant breeders' attempts to build resistance into host plants. Scientists say learning how to disarm the disease opens the door to finding new ways to defeat head scab and other plant diseases.

Mycotoxin Research Lab, Peoria, IL

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Kochia, a herbicide-resistant weed from the West, could pose a new challenge for Midwestern corn and soybean growers by the turn of the century. ARS scientists say *Kochia scoparia*, a member of the tumbleweed family, has already been found as far east as eastern Indiana, possibly spread by seed hitching rides on eastbound trains. Biotypes appearing in the Corn Belt resist several herbicides including triazines (such as atrazine) and acetolactate synthase inhibitors. The weed's potential to mutate into herbicide-resistant strains is heightened because it's a prolific seed producer; each plant yields thousands of seeds. Researchers say the best time to battle this weed is early spring, when the newly

germinated plant is vulnerable to herbicides in the dicamba and glyphosate chemical families. A native of Europe, kochia was introduced to the western United States by settlers. It is common in Colorado, Idaho, and Nebraska.

Crop Protection Research Lab, Urbana, IL

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Almond union mild etch is a new disease affecting almond trees in California, but researchers are gradually turning up clues that may lead to its treatment and prevention. If left uncontrolled, the disease could have major economic implications. Each year, California produces about \$1 billion worth of almonds—65 percent of the world's crop. While most affected trees survive the disease, they are stunted and produce only two-thirds the yield of healthy trees. The disease has appeared on six almond varieties, all grafted onto a rootstock—Marianna 2624—noted for its disease resistance, especially where drainage is poor. About 5 percent of California almond trees are grafted to Marianna 2624 rootstock. Based on 4 years of field observation, ARS researchers believe the disease is not contagious and does not kill trees on its own. The most severe tree losses have occurred where the disease appeared with other stress factors: soggy soil conditions, coupled with impaired grafting that restricts the flow of carbohydrates from the leaves to the roots. Researchers speculate that a tree is already weakened by this stress, its roots become vulnerable to normally harmless soil organisms.

Additional research is needed to more fully understand disease biology and to prevent outbreaks of the disease.

Crops Pathology and Genetics Research, Davis, CA

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Animal Production and Protection

Leaner pork for consumers could be a benefit of research on human obesity, according to ARS scientists. They've been intrigued by two hormones, neuropeptide-Y and leptin. These hormones work like a traffic light for the appetite--both in pigs and people. Neuropeptide-Y, found in the brain, is a "green light" that stimulates appetite. Leptin, the red light, is in fat. It signals the brain that the body is nourished. Researchers found that giving pigs leptin injections increased the amount of growth hormone in their bodies and made them eat less. Since growth hormone produces muscle, the new leptin approach may have potential for producing meatier,

leaner pork.

Richard B. Russell Research Center, Athens, GA
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Adding oil or spice to broiler chicks' feed can help stave off intestinal parasites that cause avian coccidiosis, ARS studies suggest. Coccidiosis is caused by *Eimeria* parasites. These parasites infect the upper, middle or lower parts of a chicken's intestines. The parasites cause intestinal lesions that hinder the bird's ability to absorb feed nutrients, severely stunting the bird's growth. Producers spend more than \$100 million annually to overcome the problem by adding anticoccidial drugs to starter feeds. But growing consumer demand for drug-free poultry and *Eimeria*'s building drug resistance have spurred the search for alternatives. ARS researchers test-fed groups of day-old chicks a 4-week diet of corn or soybean feed that consisted of 2 to 10 percent oil from menhaden fish, flaxseed or linseed. Birds with a 10 percent linseed oil diet had 64 percent fewer lesions from *E. tenella*, which attacks sac-like portions of the small intestine called the cecum. Scientists suspect the oil triggers a biochemical response called oxidative stress that helps kill *E. tenella*. They also tested feeds containing curcumin. It is an antioxidant in a popular spice, turmeric. A 1-percent turmeric diet resulted in 58 percent fewer lesions from *E. maxima* in the middle intestine. *Parasite Biology and Epidemiology Lab, Beltsville, MD*
Patricia Allen, (301)504-8772, pallen@ggpl.arsusda.gov

The first comprehensive video dictionary of livestock behavior is being prepared by ARS scientists. This will help producers of pigs, poultry, cattle and sheep determine if the animals' feeding, mating, grooming or other behavior is normal—or whether the behavior indicates disease or other problems that need attention. The dictionary will be based on published definitions of animal behavior and include video clips of specific behaviors. Researchers can use the dictionary to explain the behaviors and, if appropriate, recommend changes in production environments. This, in turn, could lead to improved living conditions for the animals and more efficient production methods. To prepare the dictionary, the researchers are cataloging known normal and abnormal behaviors as well as stereotypical behaviors with no identifiable purpose or function. Abnormal behaviors may include tail-biting and ear-chewing in pigs, cannibalism in chickens and wool plucking in sheep. The

causes may be linked to the animal's environment. For example, baby pigs will nudge one another with their noses when placed in a barren pen with nothing else to "root" or nudge. Rooting is a normal behavior for pigs. *Livestock Behavior Research, West Lafayette, IN*
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New, simple-to-use equations estimate how much manure a specific dairy herd produces. The equations, developed by ARS scientists, will help agricultural engineers design waste storage systems to prevent pollution of streams and rivers with nitrogen and other nutrients in manure. More jurisdictions now monitor water quality and hold dairy farmers accountable for polluting waterways. So, farmers store manure in pits or other holding facilities until it can be safely applied to fields or recycled as compost. The trouble is, a herd may produce more manure than the holding facilities are designed to contain—especially with high milk-producing cows that eat more. Current design methods use an average value for manure output. The new ARS equations make for a more accurate estimate by plugging in the farmer's own herd statistics. These include the animals' body weight, milk production and composition, feed makeup and number of lactating cows. The new equations also estimate the manure's initial nitrogen content—encouraging design of storage systems that save more of the nitrogen and thus help farmers defray fertilizer costs. And they can give policy makers a more accurate reading on nitrogen escaping into the atmosphere from dairy farms. The research is part of a broad effort to improve management of manure nutrients by studying their complete cycle—from the soil into the forage into the cow and back to the soil.

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Efforts to eradicate cattle tuberculosis in the U.S. should get a boost from a new, quick diagnostic test developed by ARS researchers. The test is based on a standard high-tech method called polymerase chain reaction (PCR). PCR makes many copies of targeted genetic material. In this instance, that gene material is found only in *Mycobacterium bovis*, the bacterial culprit in cattle tuberculosis. The new test can detect *M. bovis* in 2 to 3 days. Current methods take 2 to 3 months. M.

bovis is very similar to two other bacteria: *M. avium* and *M. paratuberculosis*. The inability to distinguish between them has limited progress toward USDA's goal of eradicating the disease by the year 2000. The new technique correctly identified *M. bovis* in 93 percent of tissue samples from which the organism had been cultured. Speedier diagnosis will help regulatory agencies take immediate action to identify the most common sources of cattle tuberculosis: imported Mexican steers, captive elk and deer, and large dairy herds with low levels of infection.

National Animal Disease Center, Ames, Iowa
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Nitrogen fertilizer can increase production of range forage, but the estimated increase in cattle gains will not be enough to pay for the fertilizer. Furthermore, not all plant species benefit equally. Those are two findings from a 14-year study on rangeland fertilization—the longest ever conducted on that subject. ARS scientists observed how annual applications of 20 or 30 pounds of nitrogen per acre in spring or fall changed the mix of rangeland plant species. After 14 years, fertilized areas sported more western wheatgrass plants—but at the expense of plants like blue grama and needleleaf sedge, whose populations declined. Some ranchers may welcome the change, depending on their current forage mix. For example, more western wheatgrass helps feed livestock early in the grazing season. Responses to the extra nitrogen varied significantly among 14 other perennial species surveyed. In all, scientists collected information on 90 plant species.

High Plains Grasslands Research, Cheyenne, WY
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Fathead minnow baitfish raised in ponds adjacent to channel catfish ponds will eat zooplankton that thrive on catfish waste. Growers simply circulate the water between the two ponds to put this environmentally friendly waste-disposal system into action. ARS scientists found that the two-pond system increases catfish production while reducing minnow production costs. Accumulated fish waste and uneaten feed now frequently limit farm-raised channel catfish production. That's because as the waste and feed decay, the decaying process uses up oxygen in the pond, creating an unhealthy environment for the fish. Circulation helps increase

oxygen levels in the water. Also, the wastewater pumped into the minnow pond provides nutrients to enrich the zooplankton on which minnows feed. This saves about \$20 per pond acre instead of using fertilizer to accomplish the same thing.

National Aquaculture Research Center, Stuttgart, AR
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Good news for catfish farmers: Copper sulfate, known to cut algae growth in ponds and protect fish against external parasites, won't leave unwanted copper in the fish's flesh. In a 4-year laboratory study for the U.S. Food and Drug Administration, ARS scientists found edible fish flesh contained no extra copper after ponds were treated with copper sulfate. The research also showed that copper concentrations in fish liver returned to normal levels within 8 weeks. Fish farmers lose an estimated \$25 million a year to external diseases in catfish. Copper sulfate has been approved by the U.S. Environmental Protection Agency as a herbicide to fight algae. But FDA has not yet approved it to control pathogens and parasites. FDA has deferred enforcement of regulations to restrict use of copper sulfate in aquaculture pending further studies on matters such as its potential to help or harm fish.

National Aquaculture Research Center, Stuttgart, AR
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Soil, Water and Air

Three renovated Mississippi lakes have been restocked with fish in a long-term research program to track the nation's water quality. In the Mississippi Delta Management Systems Evaluation Area project, ARS scientists are obtaining new information on controlling detrimental environmental effects of sediment, fertilizer and pesticides from farmland. The scientists already see one strong trend: improved farm practices mean less sediment is reaching the lakes. Sediment is a prime factor limiting fish production. It will take several years, however, to measure comprehensively how farm practices affect water quality and fish populations. The information will be used to develop educational and public awareness programs. ARS scientists worked with the Mississippi Department of Wildlife Fisheries and Parks to restock the lakes with bluegill and redear sunfish fingerlings and channel catfish in fall 1996 and with bass in spring 1997. Stocking rates were as follows: Thighman Lake (Sunflower Co.) 16,250 bluegill/redear, 1,250 catfish,

2,500 bass; Beasley Lake (Sunflower Co.), 39,000 bluegill/redear, 3,000 catfish, 4,000 bass; Deep Hollow Lake (Leflore Co.), 13,000 bluegill/redear, 1,000 catfish, 2,000 bass.

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Crop residue left on the soil may lower the amount of atrazine, a weed-killing chemical, in runoff to surface waters or leached into ground water. That's because the residue eventually boosts the soil's organic matter. An ARS study has shown that landscape position and soil organic carbon content greatly influence the amount of atrazine absorbed by the soil. The study focused on absorption of atrazine in glacial soils in Iowa and sandy soil in South Carolina under various tillage practices, including conservation tillage that leaves crop stubble on the ground. The researchers selected atrazine because of its heavy use and frequent detection in ground and surface water, especially in corn-growing states like Illinois, Iowa, and Nebraska. Although conservation tillage may not solve pesticide leaching problems in all soils, researchers can use these findings to help farmers fine-tune tillage practices to reduce contamination of ground and surface waters. The residue cover from conservation tillage has the potential to reduce atrazine runoff to surface waters in early spring.

Coastal Plains Soil, Water and Plant Research Center, Florence, South Carolina
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Farmers who irrigate their crops could save more than \$9 per acre each year by using ARS-developed computer programs to schedule irrigation. That's the finding from an 10-year ARS study in Kansas. Researchers hope data from the study will convince other farmers to schedule irrigation. The ARS scheduling programs calculate water needs by incorporating local weather data with complex equations that account for all water used—including moisture transpired from plant leaves and evaporated from the soil. The study on a 4,200-acre farm in south-central Kansas revealed that farmers who use scheduling programs apply about 20 percent less water than neighbors who water when crops "look thirsty." Pumping less water cuts energy use and reduces the risk of flushing fertilizer below crop roots. Wasted fertilizer not only costs farmers directly but also

is a potential contaminant to water supplies. Five percent of the 190,000 irrigated farms in the 27 leading agricultural states use a commercial scheduling service. Another 2.5 percent use their own computers to generate a schedule.

Water Management Research, Fort Collins, CO
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A new tillage technique combines the best of conventional and conservation tillage techniques to control both weeds and erosion. With the new "mow-plow" method, a standard moldboard plow, pulled by a tractor, deeply tills the soil and buries weed seeds so they don't sprout. However, soil-protecting stems, stalks and other residue from a previous crop don't get buried. That's because of a modified combine header attached to the tractor's front end. The header cuts and lifts old stubble that lies in the plow's path, then dumps it on the adjacent, freshly plowed furrows. There, it shields the soil from erosion. ARS scientists developed the technique for the 4.5-million-acre wheat-growing region of Washington, Oregon, and Idaho. The region receives little rainfall; land is left fallow every other year to collect water for the next year's wheat crop. But the soil often freezes during winter, so rain and melting snow water don't soak into the soil. Instead, the water washes away soil—up to 150 tons an acre. Normally, farmers leave crop residue on the field as long as possible, but weeds can take over during the fallow year. With the mow-plow method, growers should be able to manage both weeds and erosion.

Columbia Plateau Conservation Research Center, Pendleton, OR
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Advances in understanding of the positive relationship between the ecology of soil microbes and nutrient availability could someday enable farmers to take better advantage of stored nutrients in soil and use less commercial fertilizer. For the past 10 years, ARS scientists have been studying prairie-derived Midwestern agricultural soils as well as soils from the North American Great Plains and other sites across the United States. They examine soil organic matter, nutrient cycling, and tiny soil clumps called aggregates. Unbroken, intact aggregates are "glued" together by organic material produced by soil microbes as they dine on bits of decaying roots and transform them into particulate organic matter

or POM—a rich source of nutrients. The scientists found that when tillage breaks up soil aggregates, the nutrient-rich organic matter that was within them quickly decomposes. The nutrients are released when no plants are growing that can use them. These nutrients are often lost to leaching. By contrast, in untilled native prairie, nutrient-use is efficient and, as a result, leaching losses are low. In undisturbed prairies, microbes and plants are “in sync”—nutrients are released when and where the plants are ready to use them.

National Soil Tilth Lab, Ames, Iowa

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A newly discovered protein produced by fungi may be the "glue" that holds soils together in granules, making it easier for air and water to move through the soil.

This improved circulation helps water move down to plant roots and creates a healthier environment for plants and beneficial microorganisms in the soil. The ARS scientist who discovered the new protein named it "glomalin" for the Glomales fungi that secrete the gooey substance. One early discovery: Farming practices can affect glomalin levels. In tests, the granules from no-till corn plots were more stable and contained more glomalin than those from tilled plots. Soils with well-stabilized granular structure are less prone to erosion by wind or water. Tests of soils from across the United States show glomalin is most abundant in eastern soils, accounting for up to 2 percent of the weight of a soil granule. ARS scientists have also related glomalin to stability of soil granules from samples sent from around the world.

Soil Microbial Systems Lab, Beltsville, MD

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Simulated rainfall studies show farmers who take land out of USDA's Conservation Reserve Program (CRP) should minimize cultivation and plant cover crops.

This will hold down soil erosion and boost the soil's ability to retain vital water. Another recommendation: Plant hay and graze pastures instead of growing row crops such as corn. ARS scientists used rainfall simulators to measure soil and water movement on plots of former CRP land. They found a rapid increase in soil erosion on environmentally fragile land. The multistate studies focused mostly on areas west of the Mississippi River where CRP acreage is widespread. Under the CRP, farmers voluntarily sign a 10-year contract to take environmentally fragile land out of production.

Approximately 36 million acres of land west of the Mississippi River have been enrolled in CRP since the program began in 1986. The first contracts expired Dec. 31, 1995. Tillage on former CRP land without protective conservation practices could accelerate soil erosion and nonpoint water pollution, wiping out environmental gains accrued during participation in the program.

Soil and Water Conservation Research, Lincoln, NE

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Thanks largely to ARS research, 13 western States in the past 3 years have approved farm use of an erosion-fighting white powder called polyacrylamide, or PAM.

State regulatory agencies made their decisions using data from large-scale field tests by ARS scientists in Idaho. The tests showed that an ounce of water-soluble, negatively charged PAM mixed with irrigation water anchors as much as 1,000 pounds of topsoil that might otherwise be swept away when irrigation water rushes down furrows. ARS scientists also developed a new test to detect PAM residue in runoff water. The assay showed that 99 percent of the applied PAM remains on treated fields to safely biodegrade if mixed with irrigation water at the prescribed rate of 10 parts per million. That's a tablespoon of PAM for every 750 gallons of irrigation water until the first of this water reaches the end of the furrow. The efficient, cost-effective techniques that the scientists produced for using PAM on furrow-irrigated fields boosted use of the soil-saver on U.S. farms to more than 400,000 acres in 1996.

Northwest Irrigation and Soils Research Lab, Kimberly, ID

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Over the next 50 to 100 years, western mountain snowpacks may gradually supply less water from melting snow in late spring because of global warming. That's because the warmer year-round temperatures could result in winter precipitation in the form of rain rather than snow, and the rainwater runs off immediately. The warmer winter temperatures also would increase snowpack moisture loss from melting and evaporation. Those are just two of the predictions from new ARS computer modeling studies. The ARS researchers used three different computer-based mathematical models to predict potential snowmelt changes in seven basins. They assumed an average temperature increase of 5 to 9 degrees F, a range used by many climate researchers worldwide.

The ARS analysis was the first of its kind to represent a diverse array of western watersheds. One finding: Overall yield from watersheds—measured by water flow from rain- and snow-fed streams—might be up to 30 percent less than in 1975, the year the scientists selected for comparison. High-elevation watersheds provide 50 to 80 percent of the West's water for farmers, city dwellers, and other downstream users. Since the changes should be gradual, farmers and others have time to prepare. Farmers, for example, will need to know what kinds of crops could perform best under the changed conditions. The scientists are expanding and fine-tuning the forecast models.

Northwest Watershed Research Center, Boise ID

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Hydrology Lab, Beltsville, MD

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An experimental irrigation system is applying precise amounts of water and chemicals to a Colorado corn field to hold down costs and maximize farm profits while protecting the environment. Engineers with ARS and Valmont Industries developed the applicators to apply water and dissolved fertilizer or herbicide at rates ranging from 3 to 200 gallons per acre in a single pass. Application rates vary according to plant needs in different areas of the 26-acre test field. One part of the system is a modification of a self-propelled linear sprinkler—basically a big pipe that passes over the crop from one end of the field to the other. Groups of computer-controlled conventional sprinkler heads operate independently, delivering precise but varying amounts of water as needed across the field. The system's second part is a low-volume applicator with smaller sprinkler heads programmed to spray at intervals ranging from 4 seconds to 1 minute to apply agricultural chemicals. Computers and a commercial radio telemetry system control the application patterns for both parts of the system. After three growing seasons, researchers are encouraged by the savings in water and chemical use. Future modifications could incorporate satellite images to better target and control water applications.

Water Management Research, Fort Collins, CO

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Computer Systems and Models

Beekeepers are using a new ARS computer program to help manage their cash flow and project their profit margins. The free program, called BK-ECONOMICS (the BK stands for beekeeping) has a spreadsheet component to track loans and equipment, labor, vehicle, and insurance expenditures. A database component helps beekeepers market their honey. The program also helps beekeepers locate apiculture specialists in their state, calculate loan terms, and simulate consequences of business expansion plans. This can help the beginning apiarist decide whether to buy or lease new equipment or simply make do with existing equipment until a later date. *Carl Hayden Bee Research Lab, Tucson, AZ*
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Quarterly Report

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Into the Marketplace

Cooperative Research and Development Agreements

...With DuPont Agricultural Products, Newark, DE, to further develop AAL-toxin, a new ARS-patented weed killer, for agricultural uses. This fungal compound killed jimsonweed and other pesky broadleaf weeds in lab studies. AAL-toxin is produced by the fungus *Alternaria alternata* f. sp. *lycopersici*. ARS scientists found that it kills several weeds that are pests of row crops such as soybeans, cotton, rice and corn. Weeds in these crops

Contact the scientists listed for further information on each research project. For general questions about this report, contact Hank Becker, ARS Information, 6303 Ivy Lane, 4th Floor, Greenbelt, MD 20770, (301) 344-2769, hbecker@asrr.arsusda.gov

Items marked with the word PATENT are being patented by ARS. For more information on patents, CRADAs and patent licenses, contact ARS Office of Technology Transfer, Bldg. 005, Rm. 416, BARC-West, Beltsville, MD 20705, (301) 504-5734. Questions about a company's product and/or research should be directed to the company itself.

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cost farmers billions of dollars each year. In lab tests, weeds that succumbed include duckweeds (*Lemna* species), jimsonweed (*Datura stramonium*), black nightshade (*Solanum nigrum*), prickly sida (*Sida spinosa*), redroot pigweed (*Amaranthus retroflexus*) and northern jointvetch (*Aeschynomene virginica*). Some *A. alternata* fungi are known to promote spoilage of fruits, vegetables and grains. But using AAL-toxin to kill weeds doesn't pose a hazard to the crops and should be safe for the environment and wildlife. It can be used before or after weeds emerge and is effective as a spray, mixed with water or alone. (PATENT 5,256,628)

Southern Weed Science Research Unit, Stoneville, MS
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Licenses

...To PhotoDye International, Inc., Baltimore, MD, for patented formulations of SureDye, which kills fruit flies. SureDye is a mixture of a bait and dye--red and sometimes yellow as well. The product quickly kills several species of fruit fly pests including Mediterranean and Mexican fruit flies. ARS and PhotoDye developed and tested SureDye under cooperative research and development agreements. SureDye may be an alternative to insecticides like malathion that can be toxic to humans and beneficial insects. The mixture can be placed in traps or applied as a fine spray. The bait attracts the flies and stimulates them to feed. When they consume the SureDye, they succumb within a few hours' exposure to sunlight. Light speeds the dye's activity, which destroys insect cells. Under an experimental use permit from the U.S. Environmental Protection Agency, ARS, PhotoDye and other cooperators have field-tested SureDye formulations in California, Florida, Hawaii and Texas. Outdoor tests have also been conducted in Brazil, Guatemala, Mexico, Morocco, South Africa and Surinam. The outdoor trials have been in citrus, mango, carambola and other tropical and subtropical crops. Fruit fly targets have included Caribbean, carambola,

Mediterranean, Mexican, oriental and other crop-damaging fruit fly species that can be quarantine pests. While the baits are powerfully attractive to tropical fruit flies, they are unappealing to honeybees, ladybugs and parasitic wasps that attack pests. The dyes, primarily D&C Red No. 28, already are approved by the Food and Drug Administration for use in drugs and cosmetics including lipstick, antacids and other products. ARS-led tests with fruit flies, Colorado potato beetles and other pests continue to explore photoactive dye as an effective, environmentally friendly insecticide.

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...To Monsanto, St. Louis, MO, to use a new corn fiber oil in a variety of foods and food ingredients. Feeding studies with hamsters at the University of Massachusetts indicated the oil significantly lowered total serum cholesterol and artery-clogging LDL cholesterol. A patent on the product, called Amaizing Oil, will be held jointly by ARS and the University of Massachusetts. The oil was extracted from the hull of corn kernels. Corn fiber is a low-value byproduct of wet milling, the industrial process that produces starch, sweeteners, fuel grade ethanol and other products from corn. About 4 million tons of fiber--which could yield about 80,000 tons of corn fiber oil--are produced by the corn-processing industry each year. This waste byproduct is now sold for about 5 cents a pound as an ingredient in cattle feed. Commercialization of this technology could also lower production costs of other corn-derived products like fuel ethanol. It has the potential to benefit the U.S. economy by replacing imported petroleum, creating new jobs, providing new uses for agricultural byproducts and increasing income for processors and growers, as well as developing healthy new foods for consumers. (Patent 08/569,473)

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Patents

A new method for getting artificial chemicals through an insect's tough skin, or cuticle could lead to innovative pest controls. ARS researchers have developed several artificial neuropeptides--natural chemicals that control insect behavior and development. The problem: The neuropeptides normally can't penetrate an insect's skin so they can start working. ARS scientists formulated a greasy molecule from boron, carbon and other ingredients. The molecule matches the physical characteristics of the insect's cuticle so that it's easily absorbed. For the first application of the new molecules, researchers designed a chemical mimic of a neuropeptide chemical that in nature causes adult female corn earworms to produce a sex attractant or pheromone. In the laboratory, scientists used the neuropeptide mimic--helped along by the greasy molecule--to stimulate pheromones in an earworm for 20 hours. The strategy is to cause the insect to run out of pheromone-making chemicals, making it impossible for the insect to attract mates. Each year, corn earworms cause \$1.2 billion in damage to corn, cotton, and tomatoes. They are becoming resistant to insecticides now on the market. (Patent Application 08/700,915)

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ARS scientists have designed and patented a machine that uses steam and vacuum to quickly and inexpensively kill bacteria such as *Salmonella* on the surface of raw poultry, beef and pork. In less than a second, the new machine kills 99.99 percent of bacteria by heating the meat surface with quick bursts of steam at 290 ° F, then cooling it with vacuum. The process does not cook the surface of the meat, a problem that has prevented industry from adopting other thermal processes. Consumers prefer meat with a raw appearance. A commercial version of the machine for poultry could treat 4,000 birds per hour. Each machine could be built with multiple treatment chambers. Using

this equipment should add no more than a cent per pound to processing costs. (Patent 5,281,428)

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Plant breeders worldwide might someday use a laboratory-built protein from ARS to screen promising new plants. Known as a monoclonal antibody, the protein seeks out and binds to bitter-tasting, unwanted natural compounds called glycoalkaloids in three crops--potatoes, tomatoes and eggplants. Plans call for using the monoclonal antibody in a simple, inexpensive test kit that could help breeders identify experimental plants that exceed acceptable levels of glycoalkaloids. ARS researchers named the new monoclonal antibody "Sol-129" after "Solanaceae," the botanical group to which each of these three solanaceous crops belongs. The idea of using monoclonal antibodies to detect glycoalkaloids isn't new. But the ARS-developed antibody is apparently the first to detect the main glycoalkaloids of all three vegetables. (Patent 5,614,408).

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Need to know the mass of an object that is literally too hot to handle? A new method that uses microwaves may help. The technique was originally conceived because ARS engineers wanted a quick and inexpensive way to measure moisture content in corn kernels. They developed a system that uses microwaves to give accurate moisture readings without harming the seeds. The method also works on peanuts and soybeans. In fact, it works so well the researchers soon realized it may have broader application in fields such as manufacturing or materials handling. It can measure the mass of objects too dangerous to touch, such as molten ceramics or glass. The scale can take measurements in as little as 20 milliseconds. Best of all, it can be easily manufactured with readily available components. The researchers received a patent (No. 5,554,935) on the technology and it is now available for license.

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Natural compounds called limonoid glucosides have shown promise as potential biological insecticides and anti-tumor agents. Now it's commercially feasible to manufacture these compounds, thanks to techniques developed by ARS and Japanese scientists. ARS scientists discovered that citrus fruits produce the compounds to counteract bittering chemicals contained in the fruit. But until now, extracting limonoid glucosides from orange and other citrus pulp required a time-consuming enzyme treatment that was impractical on a large scale. Recently, ARS and Japanese scientists developed a method that removes up to 100 percent of the compounds without pretreatment. Citrus waste is passed through a chamber containing an absorbent that catches the compounds. A solvent then extracts high concentrations of limonoid glucosides. (Patent Application 08/595,607).

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Soil, Water and Air Quality

Tillage techniques can be designed to help earthworms build tunnels a certain way--and thus help protect groundwater supplies from fertilizers and pesticides, ARS lab studies have found. In farm fields, worm tunnels help crops by loosening, draining and aerating soil, providing paths for roots and mixing in organic matter, the worms' food supply. The tunnels also help keep soil water free of harmful chemicals by harboring microorganisms that degrade pesticides and fertilizers. Worms dig these tunnels simply to find organic matter to eat. But the new study found tillage can affect the location of the worm's diet, with implications for groundwater. In lab studies with a common earthworm, *Aporrectodea tuberculata*, researchers discovered that worms tunnel at random until they find food. Subsequent food searches follow patterns that vary by tillage. No-till or reduced tillage, which leaves crop residue on the surface, encourages a network of vertical burrows and depressions. This tends to funnel water rapidly downward through soil layers, reducing the water's opportunity to remove fertilizers and some other chemicals in soil. Increased tillage leads to a less desirable pattern: horizontal and meandering tunnels. Water moves more slowly, increasing the odds it can bring along chemicals. The researchers plan field studies aimed at finding new ways for using tillage

techniques to encourage vertical earthworm burrows.
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A natural enzyme that helps chickens and pigs retain their diet's phosphate could be closer to widespread use as a commercial feed additive. Adding the enzyme, phytase, to animal feed would help improve water quality by reducing phosphate amounts and runoff in manure. Feeding studies indicate hogs and chicks retain up to 60 percent of their diet's phosphate when phytase is added. This means less gets excreted into the environment. But commercial use of phytase in the U.S. has been limited. Mainly, that's because the enzyme breaks down when exposed to the high temperatures used to process feed into pellets. Now, ARS scientists are developing a heat-resistant version of phytase from *Aspergillus* fungi. One fungal isolate produces a phytase capable of withstanding 160° F for several minutes. But it lacks the shelf life and other desirable properties of a commercial phytase produced by *A. niger*. The scientists are using recombinant techniques to design a superior enzyme that has the best of both worlds: greater heat stability and longer shelf life. They are seeking a commercial collaborator to help further develop superior phytase enzymes for use in soybean meal and other feeds.
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Buffer areas called riparian zones protect stream water from herbicide runoff, ARS researchers have found. They conducted a 3-year experiment testing a standard buffer designed by USDA's Natural Resource Conservation Service. The buffer has three subzones. The first extends about 15 feet from the streambank and is planted with native and hardwood trees. The second subzone, about 20 feet wide, is planted with conifers, hardwoods and other tree species that can be periodically cut for timber. The third subzone, closest to the crop field, is a swath of thick-stemmed grasses. In their study, ARS researchers applied two common herbicides, atrazine and alachlor, to a corn field. They then tracked the chemicals' movement into a nearby grass and riparian buffer at the field's lowest end. At the corn field's edge, they detected concentrations of atrazine (34 parts per billion) and alachlor (9 ppb). But near the stream, they only detected the chemicals at concentrations of 1 ppb or

less. This indicated that the buffers worked--broke down, soaked up or otherwise removed herbicide in both runoff and shallow groundwater. Runoff can also harbor excess fertilizers, sediment and other pollutants that endanger water quality.

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Thwarting next year's pink bollworms by burying the whole stalks of this year's harvested cotton plants--instead of shredding the stalks--reduces on-farm energy use by nearly 70 percent. That's according to preliminary ARS experiments with a new, whole-stalk-burial tool that is mounted to a tractor. After harvest, cotton growers in California, Arizona and Texas are required by law to plow down their fields. That prevents the plants from resuming growth in the spring and provides convenient housing for newly emerged pink bollworms. ARS is testing a device that buries the stalks with only one or two passes instead of the normal seven. This reduces soil compaction. The implement presses the stalks into a 6-inch-thick rope, then buries the strand. Crop yields from research plots cleared with the new implement equaled those from fields cleared with conventional tools. ARS engineers are making key modifications to the device under a 3-year cooperative research and development agreement with the manufacturer, Pegasus Machinery Co., Tucson, AZ. Buried strands may take longer to decompose than conventionally shredded stalks. Scientists want to determine if this will prolong the availability of organic material fed on by microorganisms that enrich arid soils in cotton-growing regions of the southwest, including California, a leading producer of this crop.

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Food Safety and Quality

Two more Hawaiian packing houses now use a tactic developed by ARS and the University of Hawaii to ensure that crop-destroying fruit flies won't hitchhike to the U.S. inside papaya shipments. The two packing houses are Hawaii Fruit Growers, a cooperative on the island of Molokai, and Dole Food Company Hawaii on the island of Oahu. Sunrise Packers, Kauai, has used the technology since 1993. The approach requires loading

papayas into a steel chamber, then heating the fruit to 117 ° F over a period of at least 4 hours. Then, the fruit is cooled for about an hour. ARS experiments with more than a quarter-million fresh papaya and more than one million fruit flies proved that the technique kills Mediterranean and oriental fruit flies and melon flies that might hide inside the sweet, juicy papayas. The process helps prevent the spread of these insects to mainland U.S. orchards, fields and backyard gardens. ARS registered the technology with the U.S. Patent and Trademark Office in 1990. The University of Hawaii is seeking a patent for hot-forced air equipment.

Tropical Fruit, Vegetable and Ornamental Crops

Research Laboratory, Hilo, HI

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Budget-conscious consumers may someday be able to enjoy tender, tasty and affordable abalone. For that, they can thank the papaya--and food scientists. Favored blue abalones (*Haliotis fulgens*) today sell for about \$50 a can on the West Coast. They have a savory reputation and a tender, yet firm, texture. In a cooperative project, ARS and University of Georgia scientists used a food-grade enzyme to tenderize the blue's tough cousin, *H. cracherodii*, black abalone. The tougher black abalone currently sells for only about \$10 a can and is marketed mainly in Mexico. The scientists knew that papain, an enzyme derived from papaya, would break down collagen in abalone tissue. But they needed to determine how much papain was needed to tenderize black abalones without damaging flavor. With a texture analyzer--a sort of mechanical "chewer"--they calculated the relative difficulty of chewing both types of abalone. They also used a trained taste panel to confirm and refine their texture and flavor findings.

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A new commercial test uses custom-tailored molecules developed by ARS scientists to detect *E. coli* 0157:H7 and other disease-causing strains of this bacterium in meat and other food products. The molecules are monoclonal antibodies. Highly specific and sensitive, the improved antibodies make the test capable of readily detecting a single bacterium in a food sample as small as

1 gram, incubated overnight. Until now, quick commercial tests used less specific antibodies that detected all *E. coli* 0157 serotypes--nonpathogenic, as well as pathogenic--plus a subgroup of other bacteria. Specificity can be critical in testing meat and other food products. Incorrect reports that pathogens are present can alarm consumers and have significant financial impacts on companies.

U.S. Meat Animal Research Center, Clay Center, NE

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Scientists have begun a nationwide bacteria hunt to learn where chicken pathogens, such as *Salmonella* and *Campylobacter*, might get their start on farms.

This could lead to improved methods for stopping pathogens before they can reach consumers. Five top poultry producers have invited ARS scientists to comb their farms in this project, the largest of its kind in the U.S. The year-long study will sample poultry farms in Arkansas, California Georgia, Mississippi and the Delmarva peninsula of Delaware, Maryland and Virginia. Researchers will focus on 10 broiler production farms. They will use genetic tests to identify bacteria they collect at about 25 sites on each farm. Collection sites will include feed bins, insects, hatcheries, farm pets --even farmers' bootsoles. The information will help researchers identify farm areas where additional control may be needed to prevent poultry from being contaminated by pathogens.

Richard B. Russell Research Center, Athens, GA

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For the first time, a computer model attempts to simulate every step in poultry production to check for potential microbial contamination. ARS scientists developed S-RAMP (*Salmonella* Risk Assessment Modeling Program) to gauge each poultry-processing stage for three factors: contamination (the presence of disease-causing microorganisms), reduction (the effectiveness of control measures against the microorganisms) and growth (the rate at which microorganisms take hold and grow.) The program predicts numbers of *Salmonella* organisms that might be present on the meat. This class of software has become crucial to meat producers in the wake of USDA's Hazard Analysis and Critical Control Points program. The HACCP regulation, which took effect in 1996,

requires all poultry processors to identify potential contamination sites and take steps to reduce risk. *Microbial Food Safety Research Unit, Princess Anne, MD*
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A new laboratory growth medium simplifies food safety research by making bacteria, such as *Salmonella*, boost their output of proteins and carbohydrates associated with illness from poultry contamination. Growing pathogenic bacterium on this medium causes nearly a 10-fold increase in production of the harmful proteins, making their detection easier. The medium even works on strains that normally don't make these proteins. This means the medium could expose a potentially dangerous side of bacteria previously considered harmless. ARS researchers are seeking new ways to use the medium. For example, scientists interested in developing new vaccines might use the medium to "mine" potentially valuable but hard-to-find proteins from bacterial cells. The medium may also have uses in improving existing vaccines, especially those using killed bacteria. A drug company lab could use the medium to aid evaluations of a protein's quality before harvesting it from a candidate bacterium. This would help ensure consistency from one drug batch to the next. *Southeast Poultry Research Laboratory, Athens, GA*
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Animal Production and Protection

A new genetic sequence specific for *Mycobacterium paratuberculosis* plays a key role in new tests now under development to detect Johne's disease, a \$1.5 billion a year problem for U.S. dairy producers. The gene sequence for detecting *M. paratuberculosis*--the culprit behind Johne's disease--was identified by ARS researchers. Johne's disease cuts milk production, animal weight and reproduction. The new DNA-based test will report results in only 2 to 3 days. Current tests search for antibodies that aren't usually detectable until cows have been infected for several years, giving *M. paratuberculosis* a costly headstart in the herd. Early diagnosis is critical to eliminating the disease because the primary control method is removal of infected animals from the herd. Infected animals may not show signs of

disease, but can still pass the organism to healthy animals.

National Animal Disease Center, Ames, IA
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A new 10-minute test rates the sexual adequacy of male swine as reliably as two earlier tests, and with less expense. The new test requires only one female swine to rate a boar's sexual behavior. The other two tests require more females or take much longer. ARS scientists compared results for 20 purebred boars of various breeds with each test. Whether a boar rated high, intermediate or low in sexual behavior, its conduct was consistent in all three tests, the scientists found. The new test involves injecting a neutered female swine with a hormone, estradiol benzoate. This induces estrous behavior that makes her receptive to mating. In one of the earlier tests, each boar was penned for 10 minutes with three female swine--two estrous-induced and one nonestrous animal. In the other previously existing test, each boar was kept for nearly 5 days with a similar group of test females.

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The United States is the world's leading exporter of dairy bull semen. To maintain this valuable market share, ARS scientists evaluate about 128,000 U.S. bulls based on data collected from more than 20 million of their daughters. Each year, the scientists process and evaluate millions of new records from these female offspring that indicate important genetic traits, such as milk production and composition. The production data are initially collected by the National Dairy Herd Improvement Association. The researchers forward their results to INTERBULL--the independent International Bull Evaluation Service. Twice each year, INTERBULL evaluates for its 20 participating nations nearly 90,000 recent bulls from 6 breeds of dairy cattle. INTERBULL's long-term objectives are to improve milk yield and quality, increase resistance to diseases like mastitis, and preserve genetic diversity. But its short-term objective is to rank the bulls, enabling breeders to select the world's best bulls to sire daughters based on objective criteria. American bull semen continually ranks high on INTERBULL evaluations, reflecting the United States' ability to stay competitive in breeding

markets internationally. Export sales of U.S. bull semen exceed \$60 million a year.

Animal Improvement Programs Laboratory, Beltsville, MD

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A scientific first at ARS--deleting genes from the mammary gland cells of mice--could have implications for milk production in cows and for breast cancer in humans. The scientists developed transgenic mice in which they can delete some genes from mammary gland cells. Until now, gene deletion was not possible in mammary glands of livestock. The transgenic mice were born with new genes--inserted by the researchers--known as a "cre-lox recombinase system." Cre-lox recombinase genes originate from bacterial viruses. In such viruses, these genes can naturally cut out DNA sequences. The new approach is directed toward learning to delete specific genes, such as milk protein genes, from cells of a cow's mammary glands. Scientists can then determine whether specific genes affect mammary gland functions. The technique also could help medical researchers define genetic contributions to breast cancer, by allowing them to insert or delete various genes in laboratory cell cultures and study them.

Gene Evaluation and Mapping Laboratory, Beltsville, MD

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Feeding dietary iron to channel catfish does not protect them against dying from enteric septicemia of catfish (ESC) caused by the bacterium *Edwardsiella ictaluri*. This bacterial killer costs catfish farmers about \$50 million a year in losses. ARS scientists are evaluating channel catfish diets for optimum growth and disease resistance. One ARS study focused on dietary elements, their interactions and feeding management to enhance immunity and disease resistance against ESC. The finding: While iron supplements improved growth rate and survival of catfish in general, they did not protect fish from ESC. The scientists will continue to search for nutritional factors that could improve fish resistance to ESC. Up next: a study of dietary protein levels and their interaction with vitamin B6 and energy.

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Human Nutrition

Interviewers under contract to ARS will visit households of about 5,000 infants and young children across the U.S. this year to gather data on the foods they eat. The children's survey is an extension of the 1994 to 96 nationwide food survey, What We Eat in America, which covered all age groups. The new survey covers children between birth and 10 years of age. The information will be combined with food intake data collected during the larger survey from about 5,700 children up to age 18. The combined data will provide the Environmental Protection Agency with enough information on children's food intakes to adequately estimate their exposure to dietary pesticide residues, as required by the 1996 Food Quality Protection Act. It will also help planners of other programs dealing with children's needs, such as food assistance and nutrition education. The interviewers will collect 2 days of food intake data, just as they did during the 1994 to 96 survey, in more than 60 areas around the country. They will ask a parent or care-giver to provide information on foods eaten by children under 6 years old during the previous 24 hours. For children 6 through 9 years, the child will be interviewed with adult help. Interviewers will visit the household again to gather the second day's data for the same child.

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Consuming extra calcium from dairy products or supplements could put older women at risk of low zinc unless they get extra zinc, too. That's the word from two recent ARS studies. In one of the new studies, lasting about 5 weeks, 18 relatively healthy women past menopause increased calcium intake to 1,360 milligrams daily. That's a little higher than the 1,200 mg now recommended for people over age 50. The women's zinc absorption dropped an average of about 2 mg, as did their zinc balance. This happened regardless of whether the extra calcium came from milk or a calcium phosphate supplement. In a second study, zinc absorption dropped by half when a group of 10 men and women took a calcium supplement with a single test meal. But adding nearly 8 mg of zinc to the calcium supplement offset this effect. The researchers looked for a zinc-calcium interaction in elderly women because they

tend to have low zinc intakes. About half of U.S. women consume less than two-thirds the Recommended Dietary Allowance of 12 mg. And the amount of zinc people absorb from their meals decreases with age. While the data are too preliminary to recommend that women taking extra calcium also increase their zinc intake, they point in that direction. The richest dietary sources of zinc are oysters, liver and beef, followed by whole-wheat products, nuts, popcorn, cheddar cheese, poultry, lamb and pork.

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Scientists can now assess a person's natural ability to fight infections with a streamlined technique developed by an ARS researcher. The new technique is called "whole blood microculture." It enables scientists to test the ability of a chemical stimulant or antigen to prompt T cells to multiply in their natural milieu--blood. T cells, the "player-coaches" of the immune system, are sensitive indicators of immune function. The new technique costs about one-third less than the standard technique. It also more than triples the number of samples technicians can handle each day. It could lead to routine screening of infants, children, the elderly and others whose immune competence may be suspect. During the past decade, the researcher has tweaked his technique into a foolproof measure of cellular immune competence for nutritional studies. He's still improving it so it can measure the chemicals immune cells use to talk to one another. Other immunologists are developing the technique for other types of research and clinical use.

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Scientists have identified a trigger behind the age-related decline in the functioning of T cells, which coordinate the body's response to infection. What's more, the scientists could reduce the effects of this trigger, a fatty substance called prostaglandin E2 (PGE2), in mouse cell cultures. The finding brings science a little closer to defining how people can maintain a healthy immune system well into old age. Researchers had suspected that PGE2 might contribute to the decline of T cell function in seniors because too much of this

inflammation-producing substance has been shown to suppress T cell activity. When they compared the PGE2-producing cells--macrophages--from old and young mice, their suspicions were confirmed. Macrophages cultured from the old mice did indeed produce more PGE2, which, in turn, reduced T cell function. While it's not the only culprit, it appears to be an important one, the researchers say. The researchers also demonstrated that the increase in PGE2 was due to higher levels and activity of an enzyme, cyclooxygenase. This enzyme is used in the production of PGE2. But adding the antioxidant vitamin E to the cell cultures reduced PGE2 levels and improved T cell function. This suggests that people might slow dysfunction of the immune system as they age by increasing body levels of vitamin E and possibly other nutrients.

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A native American grape could be a source of new health food products. The skin, pulp and seeds of muscadine grapes are loaded with resveratrol, ARS and Mississippi State University scientists have found. Resveratrol is the same compound in wines that is said to lower cholesterol levels and the risk of coronary heart disease. When purified from grapes, resveratrol has also been shown to inhibit tumor development. This research could help promote muscadines as an alternative crop for growers. About half of all muscadines now go into processing juice in the southeastern United States, where the grapes are primarily grown. Some of the remaining waste goes into low-value animal feed, while the rest pose an environmental disposal problem. But new healthy foods are being made from puree powder, produced from the waste skin, pulp and seeds. Muscadine puree powder is higher in dietary fiber than oat or rice bran. Rats that ate the powder had significantly lower LDL (bad) cholesterol levels and higher HDL (good) levels than animals in a control group. One-half serving (2 fluid ounces) of unfiltered muscadine juice, one serving of muscadine jam, one medium muscadine muffin or one-tenth serving of muscadine sauce give the same dietary amounts of resveratrol as 4 fluid ounces of red wine. Muscadines' newly found health benefits could boost the growth of the grapes--especially since ARS research has reduced from

5 to 3 years the time needed to produce a commercial crop.

*Small Fruit Research Laboratory, Poplarville, MS
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Doctors may need to take a second look--for a possible infection--when they interpret a low level of a blood protein called transferrin to mean a child or elderly person is malnourished. While malnutrition is the common diagnosis for low transferrin, recent ARS findings suggest a different problem--a bacterial or viral infection contracted from an inadequate sanitation system. This finding may have special significance for children with a condition called protein-energy malnutrition, or PEM. Children with PEM get enough calories to survive, but their diets are too low in protein. Scientists have long known that many children worldwide suffer from PEM. But the study suggests that undetected infections threaten to tip the nutritional scales against these children by reducing appetite and taxing available calories. A child with repeated undiagnosed infections may suddenly demonstrate classic symptoms of hunger, as well as low transferrin levels, possibly confounding the pediatrician and parents.

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Do the standards for children's body composition--the ratio of fat, bone and lean issue--reflect the ethnic diversity of American teenagers? A recent study offers new evidence that the standards may need revising so that pediatricians and parents can assess more accurately whether a child is growing up healthy. Growth standards are often used to indicate a child's nutritional status. But currently they refer only to age, gender and weight. The new study included 297 fit, healthy boys aged 3 to 18 years. After accounting for height, weight, age and other factors, the scientists found significant differences in the boys' growth patterns by ethnic group. Their preliminary findings suggest that, compared to the existing standard for boys approaching adolescence, African-American boys store relatively more muscle and bone, while Hispanic boys store relatively more fat. Other institutions studying children's growth standards include the U.S. National Center for Health Statistics and the World Health Organization.

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Researchers can now "tag" the beta carotene in spinach to track how the body processes this nutrient as it becomes vitamin A in the body. This will allow researchers to see how cooking techniques, including adding spices, affects the vitamin's availability to the body. There is also a need for more information on how the elderly use this nutrient. Much of the body's supply of vitamin A is derived from beta carotene, yet little is actually known about how the body converts this important precursor into vitamin A. In the tagging technique, the plants grow in a solution with safe, non-radioactive forms or isotopes of hydrogen. The plant uses this hydrogen--just as it would use regular, untagged hydrogen--as one of the atomic building blocks for making beta carotene in its leaf tissues. The researchers can then feed the "labeled spinach" to test subjects and track the beta carotene's absorption and conversion into vitamin A through blood tests.

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Crop Productivity

A new computerized system that automatically measures cotton quality at various stages of gin processing has been developed by ARS scientists.

The system predicts the effects of moisture content, color and trash and then routes the cotton through the proper mechanical cleaning and drying sequences so it gets the optimum grade. Ginners can customize their ginning process for each farmer. Field gin research from 1994 to 1996 shows farmers receive additional profits of \$10 to \$20 per bale with the customized ginning system. One Alabama gin increased farmer profits by \$16.72 per bale on about 42,000 bales in 1994, for an overall profit increase of more than \$702,000. In 1995, profits were boosted by \$21 per bale with the computerized system. The system also reduces energy costs and helps save the ginner nearly \$1 per bale.

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Agroforestry offers livestock farmers new money-making options--especially for those with limited acreage. ARS scientists studying two types of agroforestry, silvopasture and alley cropping, say farmers who plant the right tree species in their pastures

can boost their income by as much as 300 percent. In silvopasture, farmers raise trees, cows and grass on the same land. In alley cropping, farmers grow crops between tree rows while waiting for their trees to mature. Livestock farmers can use their land to make supplemental or alternative income when livestock prices are low without sacrificing their main source of income. Extra income from grazing in silvopasture is estimated at about \$3,400 a year for a 50-cow, 200-acre pasture. By planting 60 acres of a 200-acre pasture with trees over a 30-year period, extra income could increase to about \$5,000 a year. ARS researchers are looking at a wide range of alternative crops, including corn, muscadine grapes and plants with natural chemical properties used in industry, medicine and as dietary supplements, to learn which crops would work best in an agroforestry system.

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Plant breeders can identify oat varieties that produce a good measure of oatmeal by testing the oat kernels' insides--known as groats--for hardness. In research involving six genetically diverse varieties, ARS scientists observed that harder groats are less likely to break when they're separated from the hulls. Fewer broken groats mean more and bigger flakes of rolled oats and fewer siftings channeled into less valuable animal feed. Also playing a role in oatmeal yield and groat breakage is moisture content of the oats during dehulling. Too much moisture makes groats separate less easily and cleanly from the hulls. The researchers say 8 percent moisture content is ideal for efficient dehulling with minimal groat breakage.

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Planting 50 percent more corn seed than usual cuts weed seed production by 69 to 94 percent. This reduces not only weeds, but also herbicide use for years to come--while boosting corn yields. ARS researchers monitored velvetleaf weed seed production and corn yields in fields planted at 1, 1.5 and 2 times the normal rate over a 3-year period. A separate study showed that an 80 percent reduction of velvetleaf weed seeds translates into a 12 percent increase in annual farm profits. Such a reduction also eliminates herbicides in

one of every four years. Denser corn growth helps the crop plants form a tighter canopy, blocking weeds from sunlight needed to produce seeds. Dense planting can backfire, however, as the strategy requires greater soil moisture. Yields dropped one season at the 1.5 seeding rate and two seasons at the double rate because of dry spells. The researchers say farmers should try dense planting only on irrigated fields or soils with good moisture-holding capacity--and only at the 1.5 rate, at least for now. Improved corn varieties may make higher rates feasible in the future.

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A nitrogen-fixing bacterium developed by ARS researchers is helping soybean farmers boost crop yields while cutting down on commercial fertilizer expenses. ARS scientists developed, tested and patented the microbe in 1991; now it's sold by Urbana Laboratories of St. Joseph, MO, as a new seed inoculant. The ARS scientists bred the new strain from the bacterial species *Bradyrhizobium japonicum*. Soybeans harbor soil bacteria on their roots that take nitrogen from the air and convert to a form plants can use as fertilizer. This means less artificial fertilizer is needed. In field studies, the scientists' new *Bradyrhizobium* strain supplied soybean plants with 44 percent more nitrogen than another *Bradyrhizobium* strain that's widely used. Studies by Urbana and collaborators indicate this can translate to an extra two or more bushels per acre for the farmer. Urbana holds an exclusive license on the ARS strain. The company estimates its inoculant products containing the bacterium are used on 1.2 million acres of soybeans nationwide. The microbe's success is also the culmination of a 15-year research project the ARS scientists concluded in 1997.

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Planting mid-south cotton earlier in the season to shift the peak flowering period yields more bolls and more cotton fiber, a recent ARS study suggests. Cotton in the mid-south region (Mississippi, Arkansas, Louisiana and western Tennessee) suffers from insufficient sunlight. In the first year of a multi-year field study,

ARS scientists planted *Gossypium hirsutum* L. cotton during the first week of April, a month earlier than the normal planting. This procedure, called ultra-early planting, shifts the peak flowering period closer to the summer solstice--the longest daylight period--allowing the plants to soak up more light. The ultra-early planted cotton produced 11 percent more fiber, known as lint, than cotton planted at the usual time. Lint is used to make threads for clothing and other products. The greater yield was due primarily to an increase in bolls. Another advantage for growers: Cotton planted in April flowered about 2 weeks earlier than crops planted at the usual time. This earlier maturity allows growers to harvest their crop sooner and get their cotton to market earlier, when prices are higher. Also, the early planting helps cotton plants escape some insect attacks that worsen as the season progresses. On the negative side, some plants may suffer early-season cold stress, but so far, studies show that yield is still about the same as normal planting, even if the plants are cold-stressed. The scientists are trying to identify more cold-tolerant varieties.

*Cotton Physiology and Genetics Research Unit,
Stoneville, MS*

William T. Pettigrew, (601) 686-5234, bpettigr@ag.gov

Crop Diseases and Pests

An insect immigrant to the United States--

***Anoplophora glabripennis*, a longhorned wood-boring beetle--is attacking many types of maple and horse chestnut trees in Brooklyn, Amityville and Greenpoint, New York.** ARS scientists say the insects are native to Japan, Korea and south China and can live in most sections of the United States, where they could become a widespread pest. Many trees showing evidence of the beetle infestation have been cut down and chipped over the past year since the beetles were first discovered. Recently, adults and larvae were intercepted in wooden crates and braces used to transport cargo in ships at ports in California, South Carolina and Canada. Thanks to speedy ARS identification of the insect invaders, the Animal and Plant Health Inspection Service agents fumigated the cargo--so far preventing the establishment of this species in these other areas of the country. The beetle is more than an inch long and coal black with yellow or white spots and has long antennae with black and white bands. The beetle larvae bore into living trees where they remain for about 2 years before emerging as adults. Adults live about 4 weeks. A USDA advisory

committee from ARS, Forest Service and APHIS is studying eradication methods. Possible natural weapons against the pest include birds, parasitic wasps, other beetle larvae and robber fly larvae.

Systematic Entomology Laboratory, U.S. National Museum of Natural History, Washington, DC

Steve Lingafelter, (202) 382-1793,

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A new test detects a detrimental fungus in harvested soybean seeds better than existing tests or visual examination. ARS scientists believe their new test could be readily adapted for commercial use to curtail spread of the fungus, known as *Phomopsis longicolla*. This fungus causes seed decay and discoloration. Processors reject discolored soybeans, and European buyers will reject seed with an infection rate of more than 15 percent. The new test relies on DNA fingerprinting to find the fungus. The ARS researchers isolated a unique genetic sequence in *P. longicolla* that allows them to distinguish it from similar fungi that infect soybean seeds.

Crop Protection Unit, Urbana, IL

Glenn Hartman, (217) 333-3258, ghartman@uiuc.edu

The status of lychees and longans as important commercial crops in southern Florida won't be threatened by the Caribbean fruit fly. ARS scientists have found that neither fruit hosts the fly. Now Florida growers can ship these fruits throughout the United States--even to California, which considered an embargo on the fruit because it was thought to harbor the pest. California has approved the fly-free protocol that ARS scientists developed with help from the Tropical Fruit Growers of South Florida, Inc. In 1996, Florida growers harvested 1.37 million pounds of lychees, worth \$2.75 million, and 875,000 pounds of longans, valued at \$1.75 million.

Subtropical Horticulture Research Laboratory, Miami, FL

Raymond G. McGuire, (305) 238-9321, miarm@ars-grin.gov

IPM/Biological Control

Deer could bring ticks to their doom in a new ARS-led experiment to fight Lyme disease, which is transmitted to people by the ticks. ARS and collaborating scientists began the 5-year Northeast Area-

Wide Tick Control Project this fall at test sites in Connecticut, Rhode Island, New York and New Jersey. Tests in Maryland are also planned. Each site includes a residential area and has an abundance of white-tailed deer. The deer carry blacklegged ticks. The ticks' bite can infect people with the bacterium that causes Lyme disease. In the experiment, scientists will use more than 100 feeding stations, called 4-posters, to treat deer with amitraz, a chemical that kills ticks but doesn't harm the animals. Each station has a bin of corn and four, upright rollers--one at each corner. To reach the corn, deer must brush their head, neck and ears against one of the amitraz-application rollers. By August 2000, the scientists hope the tactic will reduce populations of immature ticks--called nymphs--at each test site by up to 90 percent. Nymphs are the tick growth stage that most frequently transmits Lyme to people. In 1996, more than 16,000 cases of Lyme were reported nationwide, most of those from the northeast and mid-Atlantic states.

Knipling-Bushland U.S. Livestock Insects Research Laboratory, Kerrville, TX/Parasite Biology and Epidemiology Laboratory, Beltsville, MD

John E. George, (830) 279-0339, jegeorge@kbc.com

John Carroll, (301) 504-8300,

jcarrol@ggpl.arsusda.gov

Some Indianmeal moth strains have a built-in chemical protection against the insecticide *Bacillus thuringiensis* (Bt). That's because the moths lack a key enzyme that Bt needs to kill insects. ARS studies showed that moths without this enzyme survived while eating a Bt diet. Earlier studies showed that some of these insects adapt to the toxin by altering a receptor in the gut. Now, they've found yet another way for the moths to resist Bt. While no immediate solution is at hand, this new information allows scientists to re-think current management strategies that are based on a single mechanism of resistance. Bt is a natural soil bacterium that has been used for 35 years as an alternative to chemical insecticides. Indianmeal moths are among the worst pests in stored products, primarily attacking corn and peanuts.

Grain Marketing and Production Research Center, Manhattan, KS

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A tiny parasitic fly could mean big trouble for corn earworms that ravage corn, cotton and other crops. Results from a 3-year pilot study indicate releasing the

flies into a crop field can put a sizable dent in corn earworm numbers. ARS researchers conducted the study to explore the biocontrol potential of the half-inch-long fly, *Archytas marmoratus*. Corn earworms and fall armyworm caterpillars, its natural prey, are the most destructive insect crop pests in the Southeast. They cost farmers more than \$1 billion annually in losses and chemical controls. *A. marmoratus* flies don't kill the pests directly, but use them as room and board for their maggot offspring. The fly deposits the speck-sized maggots on or near the caterpillar pests. The fly maggots burrow inside a caterpillar and feed on it as they develop. They pupate and emerge a couple of weeks later as adult flies that mate and repeat the cycle. In the pilot study, scientists released about 600 lab-reared adult flies per acre in corn fields in southern Georgia and North Carolina. They found fly maggots or pupae in up to 90 percent of the corn earworms they sampled later. Future studies will explore using standard and novel sprayer equipment to apply the fly maggots directly to plants.

Insect Biology and Population Management Research Laboratory, Tifton, GA

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A new handbook written by ARS scientists makes it easier to distinguish crop-eating flea beetles from the helpful species that eat weeds. "The Handbook of Palearctic Flea Beetles" describes 57 genera and 30 species of flea beetles native to the Palearctic region--Europe, northwest Africa and Asia north of the Himalayas. The information should prove useful to scientists who want to increase their use of flea beetles to attack weed pests. Some flea beetles are excellent natural controls for leafy spurge, a major problem in 29 Western States. Other flea beetles feed on important crop plants, such as tomatoes and potatoes, corn and mustard. ARS scientists--world experts on flea beetles--have spent over a decade researching and organizing more than 200 pages of information on this subfamily of insects. To better identify flea beetles and predict their behavior, the handbook provides information on morphology, taxonomy, geographic distribution, host plants and other data for each genus. The user-friendly manual has full-body drawings for each genus and nearly 400 other illustrations. It also has a new identification key for 30 species of *Aphthona*, the spurge-eating flea beetle genus. Handbook users might include pest management specialists, port inspectors, biocontrol

researchers and entomology students with special interest in this economically important group of insects. The handbook is published by Associated Publishers of Gainesville, FL.

Systematic Entomology Laboratory, Natural History Museum, Washington, DC

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A quarter-inch-long weevil now chomping on weedy melaleuca trees in Florida's Everglades may be joined in the future by other helpful insects. About 1,600 of the *Oxyops vitiosa* weevils, native to Australia, were turned loose in 1997 at 11 melaleuca-infested sites in Florida. Recruitment of the weevil for the biological control battle resulted from more than a decade of scrutiny by ARS scientists who proved that this beneficial insect will voraciously eat melaleuca--and only melaleuca. Potential new recruits now undergoing testing include four additional insect species from the tree's native Australia--a leaf-damaging moth and fly, a sap-sucking psyllid, and a gall-forming fly. Tests from a Brisbane, Australia, laboratory run by ARS and the Australian government led to permission from U.S. authorities to import some of these candidate species into Florida for indoors-only tests. Melaleuca, a relative of the familiar bottle-brush plant, invades an average of 14 to 15 acres per day in central and southern Florida.

Aquatic Weed Control Research Unit, Gainesville, FL
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A genetically engineered insect virus could put the kibosh on the corn earworm's destructive appetite for crops. Ultimately, the altered virus could be developed as a biopesticide spray to protect corn, soybean and other crops. Corn earworms cost U.S. farmers more than \$1.5 billion annually in crop losses and chemical control expenses. ARS researchers altered a natural baculovirus to make it more lethal to the pests. In its normal form, the virus infects the worm's gut cells to replicate and spread. But it generally doesn't kill the earworms fast enough to stop them from damaging plants. Scientists engineered the new strain using some of the insect's own hormone-making genes. The hormones normally help regulate the insect's development from caterpillar to moth. But infecting the insect with the altered virus leads to a hormonal imbalance. The imbalance makes the pest stop eating. Plus, the insect excretes much of its water. In

temperature-controlled laboratory experiments, newly hatched insects infected with the virus generally stopped eating after 48 hours. By 20 days, only 3 percent had survived and pupated, compared with 100 percent of uninfected insects. ARS has filed for a patent on the appetite-stopping gene. The scientists plan greenhouse experiments and seek commercial collaborators for field studies.

Insect Biocontrol Laboratory, Beltsville, MD

Ashok Raina, (301) 504-9396, araina@asrr.arsusda.gov

A shiny black wasp from Asia called *Lysiphlebia japonica* might help cotton plants battle the cotton aphid, one of their worst insect enemies. As a biological control or natural enemy, the wasps could reduce growers' reliance on insecticides. ARS researchers in California, working with state and university colleagues, are evaluating the pinhead-sized wasp's prowess in attacking the aphid. The egg that a female wasp deposits inside an unlucky aphid will hatch; the wasp larva that emerges will feed on and eventually kill the aphid. The scientists are monitoring the wasps' progress in small outdoor research plots at Shafter, CA. If these tests succeed, the researchers could make larger test releases in other central California cotton fields next year. ARS entomologists in Orlando, FL, were first to import the helpful wasps to control citrus pests. They sent wasp colonies to California for the cotton aphid tests.

Horticultural Crops Research Laboratory, Fresno, CA
Raymond K. Yokomi, (209) 453-3021,
ryokomi@lightspeed.net

Cotton and other crop plants could be a step closer to better drought resistance, thanks to "borrowed" genes and bioengineering. Most conventional plants can't take up water once they dry out. But genes from a South African grass and the native star moss, *Tortula ruralis*, have been identified that may help these two plants do just that. Test plants transformed with two of these genes are being studied for their ability to recover from water stress. If the experiments succeed, the next step will be transforming cotton. Earlier research at the same lab produced the first workable system for inserting genes from foreign organisms into cotton.

Cropping Systems Research, Lubbock, TX
Melvin J. Oliver, (806) 746-5353,
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Applying pesticides to cotton after sunrise reduces beet armyworm populations by 96 percent. This finding from ARS field tests is significant because the beet armyworm costs U.S. cotton growers tens of millions of dollars in crop losses and pesticide expenses each year. Beet armyworm larvae generally prefer cotton leaves. And as larval numbers rise, older ones tend to enter the flowers. But traditional predawn pesticide applications kill only about 12 percent of the larvae in flowers. That's because the flowers are still closed, shielding the pests. Once the sun rises and the flowers open, the pests are more vulnerable. On the other hand, growers have two good reasons for applying chemicals before sunrise. First, winds are lighter, so there's less risk that pesticide spray will drift. Second, bees critical for pollination are still safely inside their hives. The scientists advise growers to coordinate after-sunrise pesticide applications with nearby beekeepers to ensure that hives are temporarily moved to safer locations.

*Western Cotton Research Laboratory, Phoenix, AZ
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A new ARS-developed synthetic diet for the Colorado potato beetle--the first of its kind--will allow researchers to rear the bug in a laboratory. This key research tool will enable scientists to identify better ways to control the pest. The new diet doesn't include foliage or potato extract. ARS scientists made the gelatin-like diet based on a chemical analysis of potato leaf nutrients. The gelatin is cut into tiny cubes and served to the bugs; the cube size increases as the bugs grow from larvae to adults. The uniform diet allows researchers to mix in and evaluate potential control agents. In lab tests, scientists found that adding high levels of tomatine--a glycoalkaloid found in tomato leaves--hinders the beetle's growth. The beetle, which feeds on potato plant leaves, is the most destructive potato crop pest. Until now, evaluating and developing alternative types of control were difficult for researchers because the pest is available only for a short period each year--most abundant in May, June and July.

*Insect Biocontrol Laboratory, Beltsville, MD
John M. Domek, (301) 504-5689*

Squelching summertime weeds near the crop field could give winter wheat farmers better control over the Russian wheat aphid in parts of the Great Plains, ARS scientists found. This aphid is a major pest of U.S. winter wheat and barley. It spends the winter primarily

on these crops throughout its North American range--16 states and two Canadian provinces. From 1994 to 1997, ARS researchers monitored the pest in and near cultivated cereal fields in Oklahoma, Kansas, Colorado, Nebraska, Wyoming and Montana. After crops matured, they tracked the aphid's movement to nearby noncultivated host plants during summer--and its return to newly planted cereal crops in the fall. The scientists found that 10 grass species could sustain the pest during summer. Its favorite summer hosts: several noncultivated grasses, as well as volunteer wheat and barley plants growing within 27 yards of an infested cereal field. Volunteers can sprout from grain that escaped the harvester in the previous year. The most important of the noncultivated grasses are Canada wildrye, crested wheatgrass and squirreltail. All have large seedheads and long awns--bristle-like appendages on the seedhead. These structures provide protective niches for the aphid. Besides helping farmers improve their control over the aphid, the findings could aid in forecasting the next season's aphid populations.

*Plant Science and Water Conservation Research Laboratory, Stillwater, OK
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A new computer model could lead to significant savings for warehouse owners who store agricultural commodities such as peanuts, dried citrus pulp, corn and cocoa beans. The model helps warehouse owners pinpoint the right time to fumigate against almond moth infestations. To control these pests, warehouses are now routinely fumigated three to four times a year with phosphine at a cost of \$20,000 per fumigation. The ARS-developed computer model warns owners when a warehouse's inside temperature and moisture conditions are conducive to moth development. If temperatures are too high, managers can use fans to cool the warehouse from 75 to 65° F--sufficient to thwart moth reproduction. The model has successfully completed trial runs with almond moth infestations in peanuts, corn and dried citrus pulp.

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Plant Genetic Resources

Spring Baby, Spring Gem and Autumn Red--the newest peaches from ARS treefruit breeders in California--should give growers and shoppers a wider choice among delicious, high-quality fruit for late spring and late summer. In California, Spring Baby peaches ripen around the first week of May, and Spring Gem fruit is ready at the end of the month. Both have pleasantly firm flesh when ripe, an advantage over many other early-season peaches, which often are soft and difficult to ship without bruising. These two peaches are the product of a technique known as embryo rescue. Scientists carefully excise the tiny embryo from the immature fruit's developing pit, then nurture it on a gel-like bed of nutrients until it forms a healthy plant. In nature, embryos from early-season parents are usually too small to survive. The third new variety, Autumn Red, is ready to harvest by the third week of August. A large peach, it helps meet the increasing demand for superb, fully blushed types: yellow-skinned fruit tinted with an attractive dark-red overcolor. Cuttings of all three varieties have been available to growers for at least one growing season, meaning consumers might see them in markets within about five years. California is the nation's largest producer of peaches.

Horticultural Crops Research Laboratory, Fresno, CA
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A new white-fleshed peach, White Robin, offers Southeastern Coastal Plain growers an alternative to traditional yellow-fleshed peaches. White Robin fruit are medium-sized, averaging about 2 3/8 inches in diameter. They're semi-freestone and rarely display split pits. The high-quality melting flesh is exceptionally firm and white with a few streaks of red. Skin color at maturity is about 60 to 70 percent red with a pale yellow to white background color. Ripening 87 to 90 days from full bloom (typically mid- to late-May, similar to Junegold), White Robin has no other white-fleshed competitors. It requires about 500 hours of chilling below 45° F. to break the winter rest period. It is best adapted to areas where Junegold and Flordaking, both popular yellow-fleshed varieties, are well adapted. White Robin trees will be available from Tennessee nurseries in the fall of 1998. Virus-indexed budwood is available from the Inter-regional Project No. 2 (IR-2) in Prosser, WA. Genetic material from this variety is available for

research, variety development and commercialization from the National Plant Germplasm System.

Fruit and Tree Nut Research Lab, Byron, GA
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Three new lines of grain sorghum that withstand fall armyworms and sorghum midges are now available to plant breeders. They can use the new lines, dubbed GT-IR 6, 7 and 8, to develop new commercial hybrids with better resistance than the hybrids now popular with farmers. The new hybrids might also cut growers' need for insecticides like chlorpyrifos. ARS and University of Georgia scientists developed, tested and released the new sorghum lines. They don't know exactly why the new lines fare better against the insects. But in field tests, yields from the new lines averaged 10 percent higher than from other previously released types of resistant sorghum. Researchers rated the lines' insect resistance from 1 to 5 to denote least to greatest feeding damage. All three new lines earned a 1.5 rating against fall armyworms; other varieties were rated 1.9. Only GT-IR7 showed midge resistance, scoring 1.7. U.S. farmers grow sorghum primarily for livestock feed. The nutritious grain can also be ground into flour for baked goods and other foods. Unfortunately, insects also like sorghum. Unchecked, midge larvae devour the grain as it matures inside the plant's seed head, causing yield losses of more than 50 percent. Armyworms chew on the entire plant, and, left unchecked, can decimate the sorghum crop.

Insect Biology and Population Management Research Laboratory, Tifton, GA
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A new soybean germplasm line naturally resists several leaf-eating insects, including velvetbean caterpillar and soybean looper. The new line, Plant Introduction (PI) 417061, will give breeders more options for developing insect-resistant, high-protein soybean varieties for farmers. ARS researchers identified the line among the agency's soybean germplasm collection located at the University of Illinois, Urbana. Besides insect resistance, the new line contains 44 percent protein. Previously, the most widely used source of insect resistance, PI 229358, offered only 38 percent. Soybean breeders interested in developing insect-resistant, high-protein cultivars will now have a more

desirable parent. Another benefit: The new soybean line also grows more upright. This is an advantage because plants of many other germplasm lines tend to fall over, making them difficult to harvest. Soybean breeders and researchers may obtain germplasm by contacting Randall Nelson.

ARS Soybean Research Unit, Stoneville, MS
Thomas Kilen, (601) 686-3125, kilent@ars.usda.gov
ARS Plant Physiology and Genetics Research Unit,
Urbana, IL
Randall Nelson, (217) 244-4346, rlnelson@uiuc.edu

A new bermudagrass called TifEagle can be mowed down to a mere 3 millimeters. That should make TifEagle an ideal turfgrass for putting greens at golf courses because it can maintain lush, dense growth despite frequent mowing. In studies, TifEagle outperformed the commercial cultivar Tifdwarf on both experimental fields and several golf courses from California to North Carolina. Compared to Tifdwarf, the new turfgrass doesn't produce seed heads. These reproductive structures are undesirable because they make a putting green's surface uneven. ARS scientists and collaborators at the University of Georgia in Tifton developed the grass. They will license sprigs of TifEagle to qualified turf growers under an exclusive agreement aimed at ensuring the cultivar's genetic purity.

Forage and Turf Unit, Tifton, GA
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Commercial peanut cultivars can now be bred from a new, resistant germplasm line, called VG P11, that makes corn rootworms go hungry. In the Southeast, corn rootworms are among the most destructive pests of peanuts. Unchecked, they can cause yield losses up to 40 percent. Growers use insecticides like chlorpyrifos to kill the pests. The rootworms devour peanut pegs--special runners linking the peanut to the plant--depriving the peanut of nutrients. But VG P11 peanut plants apparently have a natural chemical defense that make them unappealing and even deadly to the pest. In lab studies, up to 89 percent of rootworms died after eating a diet of VG P11 peg tissue. In field trials, VG P11 produced higher yields than NC 6, an older, resistant cultivar grown in Virginia and North Carolina. VG P11 produces large pods with high-quality oil. And this peanut's thin pink skin comes off easily, a boon for processing. ARS and Virginia Experiment Station

researchers developed, tested and released the new peanut.

Plant Genetic Resources Conservation Unit, Griffin, GA

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Pelican and Winona, the newest strawberries developed by ARS scientists, are now available at nurseries. Pelican--resistant to the major diseases anthracnose and red stele--grows well in the southern United States. It produces large, long, wedge-shaped fruit with glossy, red-orange berries. Ideal for fall planting for harvests in late winter to early spring, Pelican was developed with help from the Louisiana Agricultural Experiment Station, North Carolina Agricultural Research Service and the ARS Small Fruits Research Station in Poplarville, MS. The other new variety, Winona, is adapted to the north-central U.S. It is the result of 15 years of collaborative research between ARS and the University of Minnesota. In field tests, this winter-hardy, red-stele-resistant strawberry grew well with minimal use of chemicals to control pests and diseases. It consistently produced large, bountiful fruit in Minnesota tests. Winona may replace Blomidon, a variety popular in Minnesota that succumbed to the plant disease called June Yellows. The University of Minnesota is seeking patent protection for Winona. (Patent 700,297)

Fruit Laboratory, Beltsville, MD
Gene J. Galletta, (301) 504-5652

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Into the Marketplace

Growers, producers and exporters can spot foreign as well as domestic strains of cucumber mosaic virus with a new ARS-developed test kit now on the market. Tracking CMV is a key to limiting its damaging effects. The virus can hit farmers hard in the pocketbook. In 1992 it forced some Alabama tomato growers out of business. Faster detection will prevent such losses. The new test relies on sophisticated biochemistry but is easy to use. It is available from Agdia, Inc., of Elkhart, IN. Farmers and nursery operators simply hold a newly cut leaf against a

specially treated paperlike membrane. The membrane can be quickly analyzed at a lab or the local Extension Service office. To devise the kit, ARS scientists collected more than 140 CMV strains, including strains from South Africa, Russia and Asia. By designing antibodies—custom-built molecules—that react to strains found both in the U.S. and abroad, they ensured that the kit would be comprehensive. In 1993, cooperative research by Agdia and ARS yielded test kits for a different class of pathogens called potyviruses, which attack tulips and other flowers as well as vegetable crops. CMV is a cucumovirus.

Floral & Nursery Plants Research Unit, U.S. National Arboretum, Beltsville, MD

Hei-Ti Hsu, (301) 504-5657, hhsu@asrr.arsusda.gov

MS Bioscience of Dundee, IL, is marketing a new ARS-developed product that reduces potential salmonella contamination in poultry. The product, called PREEMPT, prevents salmonella bacteria from taking hold in the intestines of newly hatched chicks. ARS researchers at College Station, TX, isolated 29 beneficial intestinal bacteria from older birds and blended them into a mixture that can be sprayed onto newly hatched chicks to give them the same level of natural protection against salmonella as older chickens have. The U.S. Food and Drug Administration has approved this bacterial mixture based on field tests with 80,000 chickens in U.S. commercial chicken houses. ARS has patented the bacterial mixture, known originally as CF-3, and the method for producing it. *Food Animal Protection Research Laboratory, College Station, TX*

Larry H. Stanker, (409) 260-9484, stanker@tamu.edu

Red plastic mulch—developed and patented by ARS and Clemson University—is increasingly appearing in garden seed catalogs as a way to boost tomato yields. Red plastic mulch reflects onto plants higher amounts of certain growth-enhancing wavelengths of sunlight. ARS researchers found that two components of reflected light

Contact the scientists listed for further information on each research project. For general questions about this report, contact Hank Becker, ARS Information, 6303 Ivy Lane, 4th Floor, Greenbelt, MD 20770, (301) 344-2769, hbecker@asrr.arsusda.gov

Items marked with the word PATENT are being patented by ARS. For more information on patents, CRADAs and patent licenses, contact ARS Office of Technology Transfer, Bldg. 005, Rm. 416, BARC-West, Beltsville, MD 20705, (301) 504-5734. Questions about a company's product and/or research should be directed to the company itself.

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enhance plant growth: a low percentage of blue light and a high ratio of far-red to red light. Red mulch commercialized from the scientists' research is made to have precise levels of these components. In 3 years of ARS field tests, red mulch boosted tomato size up to 20 percent by increasing the plant's growth above the ground, especially in the fruit. The new mulch also conserves water and controls weeds. And the technology works for other fruits and vegetables, including strawberries, beans and turnip greens. Sonoco Products, Inc., of Hartsville, SC, licensed the ARS technology. Ken-Bar, Inc., of Reading, MA, a wholesale marketer of agricultural plastics, sells the red plastic mulch directly and through supply catalogs. Sonoco plans to get the mulch into major retail outlets by 1999. Burpee listed red plastic mulch for the first time in its 1998 spring catalog. Other catalogs listing the mulch include Gardens Alive, Gardener's Supply, Harris Seed, Snow Pond Farm Supply and Territorial Seed.

Costal Plains Soil, Water and Plant Research Laboratory, Florence, SC

Michael J. Kasperbauer, (803) 669-5203, kasper@florence.ars.usda.gov

A simple new procedure developed by ARS scientists allows the citrus industry to use more citrus peel that would otherwise go to waste. About 95 percent of Florida's citrus crop is processed into juice and other products, creating lots of orange and grapefruit peel. Some of this peel is candied and sold as a delicacy. But 25 percent of the peel used for candying is discarded because the industry's candying process produces undersized pieces. The new ARS procedure reformulates undersized pieces into uniform strips that appeal to consumers and allow industry to use all the peel. Paradise Fruit Company, Plant City, FL, is test-marketing the procedure. The company is a division of Paradise, Inc., which is responsible for about 80 percent of the candied citrus peel produced in the United States.

Citrus and Subtropical Products Laboratory, Winter Haven, FL

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New medical drugs and technology to improve cattle and swine production are just a few of the benefits that have resulted from the first decade of a

groundbreaking partnership between government and private industry. The Biotechnology Research and Development Corp. was formed in 1988 to bridge the gap between government research laboratories and the marketplace, pairing federal researchers' innovation and expertise with industry's marketing know-how. BRDC seeks out projects at government and academic laboratories in targeted research areas that meet the technology requirements of member companies represented on the BRDC board of directors. So far, BRDC has funded \$30 million in research in 140 projects. Among the fruits of BRDC's decade of government-industry matchmaking: technology to predict swine litter size, an effective vaccine against cattle shipping fever and a new method of cloning swine, now being tested in leading animal science laboratories.

Biotechnology Research and Development Corporation, Peoria, IL

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Cooperative Research and Development Agreements

...To Phytotech, Inc., Monmouth, NJ, to develop approaches using plants to remove heavy metals from contaminated soils. ARS scientists pioneered techniques to use plants to "vacuum" heavy metals—like lead, uranium and cadmium—from the soil through their roots and store them in the above-ground plant tissue. Research on this clean-up strategy, known as bioremediation, has been hampered by inadequate understanding of the basic mechanisms of heavy metal transport in plants. But in the meantime, scientists have been investigating agronomic approaches for inducing plants to accumulate large quantities of heavy metals. One promising plant is *Thlaspi caerulescens*, a small weedy member of the mustard family. At the molecular level, ARS scientists have studied how this plant takes up, transports and stores zinc and cadmium. The plant tolerates high levels of these metals in the soil and its shoots can accumulate extremely high levels—up to 40,000 parts per million of zinc and 1,500 ppm of cadmium. The metals could be extracted from the soil by harvesting the plant shoots, which then are processed for storage or for extraction of the accumulated metals. Then, these metals would no longer represent a pollution hazard, but a source of the metals.

Plant, Soil and Nutrition Laboratory, Ithaca, NY Leon Kochian, (607) 255-2454, lvk1@cornell.edu

...With Norvartis Seeds, Inc., Nampa, ID, to evaluate hybrid lines of genetically engineered sweet corn for resistance to corn earworm and fall armyworm caterpillars. Norvartis researchers engineered the corn to carry a toxin-making gene from *Bacillus thuringiensis* bacteria. Norvartis licensed this gene from Monsanto Company. The Bt toxin serves as a natural insecticide in the corn plant's leaves, husk, silks and other parts where the caterpillar pests feed. The toxin doesn't harm humans, livestock, beneficial insects or other animals. But caterpillars that consume the toxin either stop eating or die. Studies show earworms are more susceptible than fall armyworms. In feeding trials, 100 percent of earworms died after eating Bt-laced corn silks. Most armyworms survived but didn't reach their normal size. ARS scientists plan field studies to see how much less insecticide is needed when a Bt corn crop is planted. In Florida, which produces much of the nation's fresh-market corn, farmers must often spray up to 40 times a season to ensure unblemished, caterpillar-free ears. Earworms can cost farmers more than \$1 billion annually in losses and chemical control expenses.

Insect Biology and Population Management Research Laboratory, Tifton, GA

*Robert Lynch, (912) 387-2375,
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....With DeKalb Genetics Corp., DeKalb, IL, to evaluate corn hybrids that possess both natural and bioengineered sources of genetic resistance to the fall armyworm. The fall armyworm is a serious pest of corn, especially late-planted corn in the South. New commercial hybrids with greater resistance to the pests could reduce farmers' production costs and increase profits. In lab and field studies, ARS researchers evaluated worm-resistant and worm-susceptible hybrids developed by DeKalb. The company used germplasm that ARS had developed and released as a source of the natural resistance in their hybrids. They added the *Bacillus thuringiensis* (Bt) genes to both susceptible and naturally resistant hybrids. The genes command cells to produce a worm-killing protein. In research with DeKalb, ARS scientists found that combining Bt and natural resistance resulted in less damage to the crop than using either the same Bt or natural resistance alone. Fall armyworm larval survival and growth were reduced in field tests and laboratory bioassays.

Crop Science Research Laboratory, Mississippi State,

MS

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...With GFK Consulting, Ltd., San Clemente, CA, and Great Lakes Chemical Corp., West Lafayette, IN, to fine-tune a system for capturing methyl bromide after its use in fumigating harvested crops in airtight chambers. Methyl bromide kills damaging insect pests of fruits, nuts, grains and other commodities. The researchers' experimental system relies on activated carbon, made from coconut shells, to trap methyl bromide vented to it from the fumigation chambers. Lab tests under an earlier CRADA with ARS and GFK Consulting indicate activated carbon can snare up to 95 percent of the methyl bromide and that the carbon from coconut shells is superior to that from peat or bituminous coal for this specialized job. Researchers have already pilot-tested their prototype carbon-filled steel container at a packinghouse and now plan to try it out at a portside fumigation facility. When the carbon is spent, a reclamation facility operated by Great Lakes Chemical Corp. will remove the methyl bromide so the carbon can be re-used. With further heating, the used methyl bromide yields bromide salt, usable in manufacturing new methyl bromide or other chemicals. The idea of using activated carbon to trap methyl bromide that might otherwise be emitted into the atmosphere is not new. But the experimental technology may lead to the first practical, proven, carbon-based system that also reactivates the carbon and yields a usable byproduct. Production of methyl bromide is scheduled to be phased out in the United States because the chemical is thought to damage Earth's protective ozone layer.

*Horticultural Crops Research Laboratory, Fresno, CA
James G. Leesch, (209) 453-3090, jleesch@qnis.net*

...With American Biophysics Corporation, East Greenwich, RI, to develop new mosquito attractants for use in traps for surveillance and/or control. ARS scientists have identified several chemical compounds that have potential as attractants. The scientists will conduct laboratory and field tests to evaluate the commercial potential of these compounds. Since mosquitos can transmit some diseases, it is important to have better mosquito surveillance and monitoring in areas where there are disease risks. The new attractants would also be used to develop better traps for control, especially in areas such as parks, where there are

nuisance mosquitos.

Mosquito and Fly Research Unit, Gainesville, FL
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dkline@gainesville.usda.ufl.edu

...With Caterpillar, Inc., Peoria, IL, to develop improved technologies and soil compaction characteristics related to rubber-belted tracks and tires used on farm tractors. ARS scientists will compare belted tracks and tires and provide information to improve traction systems. Better traction systems on agricultural tractors will reduce soil compaction and improve tractor performance. The tractors' heavy weight can degrade the soil and reduce crop yields by making it difficult for plant seedlings to push their way through the soil. Compaction also restricts root growth and prevents the plants from getting water and nutrients. Improving agriculture tractor performance reduces fuel needed for field operations, such as tillage, planting, cultivating and harvesting. Reduced fuel use lowers energy costs and decreases the environmental impact of exhaust emissions.

National Soil Dynamics Laboratory, Auburn, AL
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derbach@eng.auburn.edu

..With Water Resources Publications, LLC, Englewood, CO, to enhance an environmentally friendly computer model, make it easier to use, publish documentation and a user's manual and market the package. ARS scientists designed the RZWQM—short for root zone water quality model—to aid farmers in finding the best ways to obtain maximum yields while protecting the environment. Within 3 to 5 years, farmers should have the model to help them pick the best tillage method, the safest types of fertilizers and the best times to apply pesticides and irrigate. RZWQM is the most complete model ever developed to simulate the effects of management on crop growth and water quality. Researchers could have it as early as fall of this year. The model will help identify the most critical gaps in research, pinpoint the type of data that should be collected, quantify and interpret results and transfer the knowledge and technology to other soils and climates.

Great Plains Systems Research Unit, Fort Collins, CO
Lajpat R. Ahuja, (970) 490-8315,
ahuja@gpsr.colostate.edu

...With Intervet, Inc., Millsboro, DE, to further test and evaluate a new ARS-developed, modified live vaccine against enteric septicemia of catfish (ESC). The new ARS vaccine is administered as a bath immersion for 7- to 10-day-old catfish. ESC is the number one disease of farm-raised catfish, causing losses of up to \$50 million annually. No other catfish vaccines against ESC are available to the catfish industry. If developed commercially, this vaccine will prevent ESC and significantly reduce the volume of antibiotics now fed to catfish to control ESC.

Fish Diseases and Parasites Research Unit, Auburn, AL
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Licenses

...To Pioneer Hi-Bred International, Johnston, IA, for a new, ARS-developed and -patented corn that could be more nutritious as feed and reduce water pollution. The new corn is low in phytic acid. Abundant in regular corn, phytic acid is a form of the nutrient phosphorus. But in its phytic acid form it cannot be used by poultry, swine and other animals with one stomach. Instead, the phosphorus winds up mainly in the animals' manure. Rain can carry excess phosphorus to waterways, where it nourishes algae. Unchecked algae blooms can consume all of the water's oxygen, choking out fish and other aquatic life. But low-phytic-acid grain holds more of a nutritionally available form of phosphorus, so up to 40 percent less of it is excreted in manure. Research may further increase the "capture" of corn's phosphorus. Cattle and other animals with multiple stomachs have natural enzymes to convert phytic acid into usable phosphorus. Feed for one-stomached animals can be treated with similar enzymes. But low-phytic-acid corn could be a less expensive, more sustainable approach. Pioneer and other hybrid corn seed producers are breeding the trait into elite corn lines. Commercial hybrids may be released in a couple of years. But this could happen only if the plants exhibit critical traits including desirable yields, nutritional qualities and pest and disease resistance. Meanwhile, ARS researchers are expanding the approach to other grains in which phytic acid ties up phosphorus: rice, barley and wheat.

Small Grains and Potato Germplasm Research, Aberdeen, ID
Victor Raboy, (208) 397-4162, vraboy@uidaho.edu.

...To The Burchell Nursery, Inc., Oakdale, CA, to sell an ARS-patented apricot variety called Robada. Sweet, plump Robada apricots have fine-textured, deep-orange flesh and are more flavorful and aromatic than many other apricots. The fruit gives growers an alternative to the five standard apricot varieties raised in U.S. commercial orchards. In California, which produces nearly all of the United States' commercial apricots, Robada ripens from mid-May until nearly the end of the month. Though intended for eating fresh, further testing should reveal whether Robada is also suited for drying, canning or freezing. ARS fruit breeders made consecutive crosses of four different sets of parent trees to produce Robada, followed by eight years of orchard observations. ARS has licensed three other nurseries to grow and sell Robada apricot trees: Agri Sun Nursery, LLC, Selma, CA; Bright's Nursery, Inc., Le Grand, CA; and GIE Star Fruits, Mondragon, France.

Horticultural Crops Research Laboratory, Fresno, CA
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Soil, Water and Air Quality

Scientists have uncovered new details about the importance of the tips of plant roots in sending signals about the soil environment to the rest of the plant. The scientists hope the information can someday help farmers minimize the effects of environmental stresses like drought and improve control over pests and diseases. The strategy would involve interpreting soil and plant data obtained by precision farming technologies such as remote sensing and yield monitors on combines. Chemical signals sent by plant roots to shoots are already known to include nitrate, a plant nutrient, and hormones such as cytokinins and abscisic acid. But when ARS scientists analyzed the growth patterns of corn root systems, they found that changes in root distribution and architecture could result from the chemical activity in the root tips—sites of cell division. These changes may increase or decrease the volume of soil accessible to the roots for taking up water and nutrients. The scientists found that the growing tips of roots sense soil conditions like availability of water and nutrients as well as soil hardness and temperature. Roots relay signals about these conditions. These signals include fluxes of ions and growth hormones. Shoots respond by regulating

production of photosynthetic enzymes and the size of small pores in leaves—which, in turn, affect photosynthesis and water use.

Central Great Plains Research, Akron, CO
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Kangaroo rats and their relatives get the credit, say researchers, for more than 90 percent of the Indian ricegrass seeds that sprout and take hold on desert rangeland ecosystems of California, Utah and Nevada. The scientists are studying way to increase the supplies of this native plant, which provides nutritious forage for wildlife and cattle. Wildlife biologists already know that Indian ricegrass seed is a favorite of the furry rodents. But a 4-year ARS study provides useful new details on the role of kangaroo rats, pocket mice and other seed-eating animals in re-seeding Western ranges. On spring and summer nights, a single kangaroo rat may gather hundreds of seeds in its fur-lined cheek pouches, then bury them in shallow hiding places or caches. But the animals often don't return for these tasty meals. They may cache more seeds than they need, fall victim to a predator or to a harsh winter, or simply forget where they put some seeds. In any event, many of the buried seeds sprout the following spring. Unfortunately, the rodents eat ricegrass seeds planted by humans just as readily as those produced within the native ecosystem. But the new study adds to the scientists' ongoing efforts to devise new ways to outwit kangaroo rats and other seed-eaters that steal seeds planted, for example, by machine in costly range re-seeding operations.

Ecology of Temperate Desert Rangelands Laboratory, Reno, NV
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A single-cell parasite, *Cryptosporidium parvum*, has for the first time been found in oysters. An ARS researcher and colleagues with Johns Hopkins University and the National Oceanic and Atmospheric Administration found oocysts—encased eggs—of the protozoan parasite in oysters in six rivers feeding the Chesapeake Bay. Some of the oysters had as many as 4,000 oocysts, many times the human infective dose. The researchers demonstrated that oocysts could develop in mice. This indicates they pose a potential risk to humans who eat raw oysters, although there have been no known cases attributed to oysters. The oocysts don't

survive temperatures above 164° F, so cooking shellfish will prevent potential infection. *C. parvum* protozoa are found in waterways worldwide. If swallowed, they can infect gastrointestinal cells, where they cause cramping and diarrhea and sometimes nausea and vomiting four to 10 days later. Because of the long incubation period, *C. parvum* is often not connected with these flu-like symptoms. Symptoms range from mild to severe in healthy people and can lead to chronic diarrhea, dehydration and death in people who have a weakened immune system. In 1993, more than 400,000 Milwaukee residents suffered *C. parvum* infections from contaminated drinking water. Smaller outbreaks have occurred around the country.

*Immunology and Disease Resistance Laboratory,
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Food Safety and Quality

A lethal mixture of dust and heat means trouble for insects that infest food-processing plants. The dust, called diatomaceous earth (DE), is made from the fossilized skeletons of aquatic plants. To test the mixture, ARS scientists and cooperators placed confused flour beetles—one of the food-processing industry's worst insect invaders—inside a Quaker Oats treatment facility in Canada last year. The researchers dusted the area with DE using hand-held dry powder sprayers. Then they raised the indoor temperature to 120° F. This combination killed 100 percent of the beetles within one day. The heat breaks down the insect's waxy exoskeleton, and the DE absorbs the wax layers, disrupting its internal water balance. The payoff for the food industry: lower heat treatment costs and better insect control using DE and heat compared with using heat treatment alone. Both Canadian and U.S. food-processing plants have used heat treatments to kill the invading pests, but a few processors are concerned about expensive installation of new heating systems in older buildings.

*U.S. Grain Marketing, Production and Research
Center, Manhattan, KS*

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Pigs genetically engineered with a growth factor gene may give consumers leaner pork in the future.

The new transgenic pigs carry a gene for insulin-like growth factor-I (IGF-I). Produced by ARS researchers in collaboration with GeneMedicine, Inc., The Woodlands, TX, the IGF-I transgenic pigs have some of the same positive carcass composition characteristics as transgenic pigs injected with a growth hormone (GH) gene. A key difference, however, is that none of the IGF-I transgenic pigs have developed the health problems encountered earlier in the GH transgenic pigs. That's because most mammalian cells already have small amounts of IGF-I, which stimulates development of bone, muscle, nerve and organ tissues. IGF-I produced in muscle increases significantly without affecting the amount in the other tissues, making the IGF-I transgenic pigs unique. ARS scientists compared pigs with and without IGF-I to see how it affected their growth rate, feed efficiency, carcass composition and general health. They compared those results with the results obtained earlier with the GH transgenic and regular pigs. The researchers found that IGF-I helped reduce carcass fat and boost lean body mass—making those hogs worth \$6 more at market than pigs without the transgene. The study also confirmed that the IGF-I pigs didn't suffer from severe health problems associated with the GH transgene. ARS scientists say this preliminary work is a first step to producing leaner pigs, but it will have to be tested on market-grade animals. The scientists' next step will be to cross IGF-I transgenic pigs with market-line hogs to see if increased levels of the hormone enhance muscle development in already lean, heavy-muscled; crossbred market hogs.

*Gene Evaluation and Mapping Laboratory, Beltsville,
MD*

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A hand-held laser instrument that's similar to airport metal detectors can alert meat packers to unseen fecal contamination within seconds. A soiled carcass can then be sanitized before the contamination spreads. ARS and Iowa State University researchers are patenting devices that illuminate unseen fecal matter on meat. The device is adaptable to any size packing plant. Currently, the industry relies on visual inspection and culturing tests for *E. coli* 0157:H7. These tests, however, are time-consuming and don't reveal the presence of other harmful bacteria, such as salmonella or campylobacter. Each year, the U.S. meat processing industry slaughters 37 million cattle, 93 million hogs, 4 million sheep, 300

million turkeys and 7.8 billion chickens, valued at more than \$50 billion.

National Animal Disease Center, Ames, IA
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A new computer model from ARS scientists evaluates potential risk of *Salmonella* infection from poultry produced by specific farm-to-table scenarios. This modeling program will help poultry companies and regulatory agencies make important food safety decisions that safeguard public health. Available at no cost on a floppy disk, the program can be used to create new models for other pathogens like *E. coli* and *Campylobacter*, and other foods including ground beef and apple cider. It is ideal for evaluating the impact of new intervention methods—such as irradiation—on the risk of foodborne disease in humans. The method can be used to evaluate the effectiveness of the new HACCP (Hazard Analysis and Critical Control Points) program that became effective in January 1998. Two major poultry producers are testing the new easy-to-use modeling system.

Eastern Regional Research Center, Microbial Food Safety Research Unit, Princess Anne, MD
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A forced hot-air treatment designed to kill Mexican fruit flies in export-bound Texas grapefruit also protects the produce from green mold spoilage. Last year, based on ARS research, USDA regulators approved the use of a quarantine treatment of forced, moist, hot air for grapefruit in Mexfly-infested areas. In their latest lab research, the scientists inoculated grapefruit with spores of *Penicillium digitatum*, the fungus that causes green mold. Then they applied the forced hot air and, after four days of storage at 70° F, looked for mold. Grapefruit exposed to the 113° F quarantine treatment had between 60 and 80 percent less mold than unheated grapefruit. Forced hot air may also reduce the need for fungicides in citrus wax by boosting biocontrol agents' effectiveness. The hot air could accelerate the growth of a heat-loving biocontrol agent while inhibiting green mold from spreading. The ARS researchers are now seeking cooperators for small-scale pilot tests.

Crop Quality and Fruit Insects Research, Weslaco, TX
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Bakers can make oat bread with texture almost like that of white bread by using flour milled from oats superheated with steam. Scientists found that steaming oats at 221° F for 20 minutes helped finely ground oat flour absorb the water necessary to mix dough. In baking experiments, the scientists determined that flour blends should contain no more than 10 percent oat flour to make an acceptable bread. Besides providing a specialty bread flavor and nutritional benefits, oat flour naturally slows bread from turning stale.

Cereal Crops Research, Fargo, ND
Douglas C. Doehlert, (701) 239-1413,
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Salad-bar banana slices could be just around the corner, thanks to ARS research that slows browning in the cut fruit. Bananas aren't offered in salad bars because they turn brown almost immediately after they're cut. But ARS scientists mixed citric acid and N-acetylcysteine—a common, sulphur-containing amino acid—to keep banana slices for 14 days at 40° F without browning. The treatment not only allows bananas to be marketed as fresh-cut, but also retards browning and reduces decay in fresh-cut slices of apple, pear, peach, plum, nectarine and avocado. Treated apples did particularly well, holding up for 50 days in cold storage without any change in flavor.

Horticultural Crops Quality Laboratory, Beltsville, MD
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ARS researchers have found that Navaho blackberries last 14 to 21 days, far exceeding the 3- to 4-day shelf life of other varieties. Farmer complaints about blackberries going soft soon after they're picked led University of Arkansas breeders to ask ARS to evaluate many varieties the university had released over the years. An ARS scientist discovered some exceptions that don't go soft quickly—notably Navaho, the first early thornless, erect-plant-type blackberry, released in 1988. Navaho stays firm 2 to 3 weeks, eclipsing even the latest breeding lines. In tests, Navaho berries were stored in coolers like those used by the industry to hold blackberries before transport to stores. A test shipment sent to the Netherlands arrived in the same condition as they were picked: firm, exceptionally sweet and consistently tasty. ARS scientists speculate that Navaho's extra firmness derives from its berry structure, cell wall structure or lower rates of enzymatic action.

Blackberry acreage in the South has steadily expanded, and the new finding has further renewed growers' interest in marketing Navaho, especially to distant markets. The research shows that high-quality blackberries are now available for consumers.

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Animal Production and Protection

The first live offspring from super-cooled pig embryos have been produced by ARS researchers. The scientists used a process called vitrification, which preserves the pig embryos in a cooled state without allowing ice crystals to form, crucial for their storage and later development. Slow-cooling below normal room temperatures—about 15°C or 59°F—is required during conventional embryo freezing methods. But embryos suffer physiological and structural changes when going from normal body temperatures to these cooler temperatures. This is why pig embryo survival, after slow cooling or conventional freezing, has been so poor. The new vitrification technology offers the \$11 billion-a-year swine industry greater opportunities for global expansion. It will allow producers to import and export valuable breeding stocks and unique germplasm without worrying about shipping live animals. Producers and consumers benefit in the long run through availability of improved livestock, providing safe, wholesome and healthy pork products at reduced costs.

*Germplasm and Gamete Physiology Laboratory,
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After trying a new approach on herd worming suggested by an ARS researcher, Pennsylvania dairy farmer Larry Lohr saw his cows give an average 4 pounds more milk per day in 1997. Plus, the cows' body weights stayed up and they excreted less nitrogen, a potential pollutant. Lohr collaborated on a 3-year ARS study of his farm, aimed at keeping brown stomach worms from nibbling into dairy producers' profits. Under the ARS-developed regimen, Lohr will de-worm his cows twice—once in spring and once in fall—instead of five to six times as in previous

years. Lohr is one of a growing group of dairy producers trying to increase their bottom line by letting cows graze when possible, rather than cutting, drying and storing the feed and serving it up later. The practice lowers feed costs. But milk production often "roller coasters" throughout the season. The study was funded by a grant from USDA's Sustainable Agriculture Research and Education Program. The ARS researcher observed that Lohr's 19-day grazing rotation perfectly fit the brown stomach worm's life cycle. Lohr followed the researcher's advice to let the cows "vacuum up" infectious larvae while they graze each paddock at the start of the season. The spring worm treatment killed these ingested larvae before they could mature and deposit eggs in the feces—which would re-infest the pasture.

*Immunology and Disease Resistance Laboratory,
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A set of new genetic probes could someday help save horses worldwide from wormlike nematode parasites. ARS scientists helped other researchers in Scotland and Australia develop the new probes based on the worms' DNA sequence. Each year, any of about 65 species of nematodes that infect horses cost owners and insurance companies millions of dollars. The parasites lower the animals' performance and productivity and sometimes kill them. Currently, accurate diagnosis is impossible because eggs in feces or larvae cultured from the eggs cannot be identified to species. Thus, treatment isn't as selective as owners and veterinarians might desire. An ARS worm expert worked with an international team to produce a checklist of nematodes that inhabit a horse's large intestine during the parasite's adult stage. Recently, ARS scientists organized an international workshop to adopt updated, uniform nomenclature for the pests. Eventually, the new probes might allow horse owners to be more selective with antiparasitic drugs. This would reduce treatment costs and extend a drug's useful life by avoiding its overuse. In the meantime, the probes will help researchers in several ways. They will help determine whether a nematode is drug-resistant or is a serious pathogen. The probes will also be used to identify the predominant species in larval cyathostomiasis—an emerging horse disease. Researchers can also use the probes to evaluate, select and enhance natural control agents for nematodes.

*Biosystematics and National Parasite Collection Unit,
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Several proteins that probably help a biting gnat transmit bluetongue, a virus of cattle and sheep, have now been pinpointed by ARS scientists. The gnat, *Culicoides variipennis*, is also called a biting fly, midge, or, because of its small size, a "no-see-um." The proteins increase blood flow to the bite area, prevent aggregation of platelets needed to close off the wound and inhibit immune system cells that would help a victim fight off the virus. Researchers already knew about similar proteins in other biting insects and ticks. But the ARS team is the first to show that *C. variipennis* secretes these specialized molecules from its salivary glands. The proteins may prove to be a better tool than the virus itself for developing a future bluetongue vaccine. That's because the many strains or serotypes of the virus can quickly develop resistance to a virus-oriented vaccine. This problem wouldn't occur with a vaccine targeted to the gnat's salivary-gland proteins. Bluetongue annually costs the U.S. livestock industry an estimated \$120 million in lost trade. Countries without the disease won't accept some American livestock exports.

*Arthropod-borne Animal Diseases Research
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Calves castrated at birth suffer less stress than calves castrated at six months of age. But the method of castration—banding or surgical—can make a difference in the amount of colostrum the calves consume. Colostrum is high-protein milk that's produced by the mother for a few days after giving birth. Colostrum contains many antibodies and increases the calves' resistance to disease. Calves castrated at birth using the banding method spend more time lying down and appear to spend less time nursing—and getting colostrum—than calves castrated at birth by surgical means. Weaning is a stressful time for calves. That stress can be heightened by production practices such as castration. Animals are castrated primarily to reduce the danger of handling males, who are often aggressive, if they're allowed to reach sexual maturity uncastrated. Castration also improves the taste

and tenderness of beef. Meat from uncastrated cattle can be tougher and may carry an unpleasant odor.

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A natural compound can help cows ward off costly mastitis infections around calving time, ARS researchers have shown. The cows make this compound—cytokine G-CSF—in skin and other body cells. G-CSF stimulates bone marrow to produce white blood cells that fight infections. In tests, cows were injected with the compound daily from days three through seven after calving. On the sixth day, the cows were challenged with a bacteria and their reactions were monitored for several more days. Half of the cows receiving G-CSF did not become infected. The other G-CSF-injected cows had shorter and less severe infections than the cows in the control group. All the G-CSF recipient cows ate well and gave more milk than cows receiving only saline. Each year, dairy producers lose as much as \$180 per cow because of mastitis, an infection of the mammary gland. These infections occur most often around calving time on more than 95 percent of all dairy farms. The benefit of using G-CSF as a preventative: less use of antibiotics in cows to treat mastitis.

*National Animal Disease Center, Ames, IA
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Animal urine could become a new source of valuable hormones and other human drugs. ARS and New York University researchers have developed transgenic mice that produce, in the lining of their bladders, human growth hormones that accumulate in the urine. Producing medicine in animal urine has the potential to be more economical than mammary gland "pharming"—the current practice of producing pharmaceuticals in the milk of transgenic animals. ARS scientists say it will be possible to collect urine from livestock within a day or two after the animals are born. This early collection has a major advantage over mammary gland pharming, since it takes two to three years before the female of most farm animal species reaches sexual maturity, gestates and lactates for the first time. Another advantage: Urine can be taken from both males and females. Pharmaceuticals such as human growth hormones, alpha antitrypsin (used for treating

emphysema) and lactoferrin (used to treat stomach infections in babies), plus other human medications, have been produced in the milk of transgenic livestock. The researchers stress that the findings are preliminary and that there are drawbacks. For example, scientists note that the bladder produces a much lower concentration of drugs than does the mammary gland. But because purification from urine should be less costly, the low concentration should not pose a major problem. The scientists say this demonstrates that the approach is feasible, but more research is needed to perfect the system.

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Black-legged deer ticks could fall prey to a naturally occurring fungus that's been tentatively identified by ARS scientists. The tick, *Ixodes scapularis*, can infect people with the bacterium responsible for causing Lyme disease. The fungus, a species of *Gliocladium*, infects the tick and feeds, grows and reproduces inside the pest. Researchers are now exploring *Gliocladium*'s potential as a tick biocontrol. One possibility: spraying a fungal spore preparation along hiking trails, backyards or other high-vegetation areas where ticks and humans cross paths. The tactic would primarily target immature ticks in the late spring and early summer. That's when their cuticle—softer at that early stage of the tick's life—is most easily penetrated by a natural enzyme the fungus produces. The enzyme helps the fungus infect its host. In lab experiments, 70 percent of tick nymphs died after being exposed to spores of the fungus. Immature nymph ticks are most likely to transmit Lyme disease. The ailment, which can be treated early on with antibiotics, causes flu-like symptoms such as fatigue, headache and joint pain. Lyme is a serious health concern in the Northeast and Midwest. It is also spread by another, closely related deer tick species called *Ixodes pacificus*.

Parasite Biology and Epidemiology Laboratory, Beltsville, MD

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Industrial (Non-Food) Products

A new mechanical harvester developed by an ARS engineer can give U.S. citrus growers an edge on the orange market and make them more competitive with Brazilian growers. The machine—which shakes the tree foliage—can harvest a 90-pound field box of citrus for 50 cents, compared with the \$1.50 it now costs for hand labor. It fills the 300 to 400 field boxes of fruit from each orchard acre 15 times faster than hand laborers. During peak season, Florida growers employ about 45,000 seasonal workers. Hand labor is expensive and may not always be available. Although most citrus is hand-harvested, some growers use trunk shakers that require chemicals to loosen ripe fruit. But there is no chemical approved for this use, and the new foliage shaker requires no loosening chemicals. With the new harvester, growers can harvest more cheaply, control when they harvest and know that their equipment is dependable. Florida's Department of Citrus has signed a cooperative research and development agreement with ARS to further investigate the harvester.

Appalachian Fruit Research Station, Kearneysville, WV
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An ARS-patented soybean ink formula for sheet-fed and heat-set web offset printing could significantly boost demand for soybeans. Sheet-fed and heat-set web offset printing have a potential market of 100 million pounds of ink for printing books and 423 million pounds of ink for magazines. ARS researchers have already patented a soy-based newspaper ink that has a market potential of 500 million pounds of ink. Soy ink's benefits to consumers: It won't rub off on your hands. It's also better for the environment because it degrades five times as fast as petroleum-based inks and it has no volatile organic chemicals. For printers, soybean oil ink offers faster and less expensive clean-up (Patent No. 5,122,188).

National Center for Agricultural Utilization Research, Peoria, IL

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Crop Diseases and Pests

A new, first-of-its-kind automated system could speed up identification of karnal bunt, a wheat fungus recently found in the southwestern United States. Some countries won't import the infected wheat containing karnal bunt-infected kernels.

Currently, wheat samples are visually inspected for the presence of spores and infected kernels. The new system automatically identifies wheat classes and defects such as bunt-infected kernels or scab. In preliminary tests, the instrument correctly identified 93 percent of all bunt-infected kernels. The instrument sorts both common and karnal bunt from healthy kernels at the rate of two kernels per second. This system was designed by ARS researchers and engineers with Perten Instruments North America, Springfield, IL.

U.S. Grain Marketing Research Center, Manhattan, KS

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Nurserymen and landscapers can help rein in a disease that is slowly dooming century-old trees near the historic Mall in the Nation's Capital. Nothing can be done to save these oak, elm and maple trees, but the spread of the bacterium *Xylella fastidiosa* by sap-sucking insects can be stemmed by growers' vigilance. *X. fastidiosa*'s calling card is leaf browning that begins on outer edges and moves inward. As the disease progresses, branches fail to revive in spring and eventually die. To save neighboring trees, nursery staff should keep vigilant and remove the stricken tree in time before insects spread the bacteria. The disease is commonly known as leaf scorch. It kills by attacking the xylem tubes that carry water within the plant. Leaf scorch has been found throughout the U.S. and in Brazil, where it attacks coffee trees. There is no cure for leaf scorch, but some plants appear to have resistance. Scientists are exploring why. They have also narrowed the list of xylem-feeding insects that may be responsible for spreading the disease.

Floral & Nursery Plants Research Unit, U.S. National Arboretum, Beltsville, MD

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The microscopic wheat mite *Aceria tosichella* has been unmasked as the culprit behind an emerging corn and wheat virus in the western United States and three other countries. The mite is a carrier of High Plains Virus (HPV), which was first observed in western corn and wheat fields in 1993, hitting especially hard in northern Texas. It has now been confirmed in more than 100 counties and 11 states, as well as in Chile, Brazil and Israel. Symptoms of HPV infection include severe stunting, yellowing, reddening and death of the lower leaves. *A. tosichella*, also known as wheat curl mite, infects plants when it injects the virus into plant tissues as it feeds. The mite also carries wheat streak mosaic virus, another threat to crops. ARS researchers have teamed with scientists at the University of Nebraska to breed new mite-resistant corn and wheat varieties.

Wheat, Sorghum, and Forage Research, Lincoln, NE
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IPM/Biological Control

Tiny proteins called peptides may help protect cotton plants from attack by *Aspergillus flavus*, *Fusarium* and other harmful fungi. ARS studies show the peptides kill certain growth stages of the fungi by forming pores in their spore walls. Once the smallest, most potent peptides are identified, scientists will engineer cotton plants with the genetic code for making the compounds to fight fungal infection. One promising candidate is Cecropin A, derived from the cecropia moth. In test-tube studies, the peptide killed 100 percent of dormant and germinating *Fusarium* fungi within 30 minutes exposure. It also killed many germinating spores of *A. flavus*. Both fungi are serious cotton pests.

Fusarium can cause root rots and seedling diseases. *A. flavus* produces a harmful substance called aflatoxin that can contaminate cotton seed, peanuts and corn. Cotton growers typically counter these and other virulent fungi with chemical fungicides. But a more environmentally friendly approach may come from genetically engineering cotton plants that make the antifungal peptides. In addition to Cecropin A, the scientists have tested peptides from frog skin, soil-dwelling bacteria, plant seeds and other natural sources.

Southern Regional Research Center, New Orleans, LA
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Future cotton-breeding lines may naturally resist *Verticillium* and *Fusarium* wilt, diseases that cost U.S. cotton producers \$114 million in yield losses in 1996. ARS and Texas A&M researchers partially purified an enzyme that cancels out a natural antibiotic—desoxyhemigossypol—produced by the cotton plant. This natural antibiotic could help protect the plant against wilt disease if the enzyme didn't destroy it. The researchers are looking for a way to block production of the meddlesome enzyme. The researchers will make an antisense gene—a gene whose specific makeup is akin to a mirror image of the enzyme-forming gene. Once inserted into a cotton plant, the antisense gene should block the enzyme and therefore strengthen the plant's natural defense system against disease. Scientists hope to accomplish this within two to three years. That's good news because chemical controls for these diseases are costly and traditional breeding techniques have limited potential for further improving resistance.

*Southern Crops Research Laboratory, College Station, TX
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Two of cotton's biggest pests, cotton bollworm and tobacco budworm, remain vulnerable to the natural insecticide *Bacillus thuringiensis* (Bt). That finding comes from an ongoing ARS project to develop a reliable system for tracking insect resistance to Bt. In 1996-97, researchers studied 67 insect colonies (24 tobacco budworm and 43 cotton bollworm) in nine states and found those insects were only slightly more tolerant to the Bt in transgenic cotton than a highly susceptible laboratory colony. This is especially important because Bt-formulated crops are a major source of insect control. Several crops, including corn, cotton and potatoes, have been genetically engineered with the Bt gene to provide "homegrown" protection against pests. Cotton with built-in Bt is grown throughout the United States and in Australia. Several pests, including the indianmeal moth, the diamondback moth and at least nine other insects, have developed resistance to Bt, which means more chemicals must be applied to control those insects. ARS researchers plan to establish Bt resistance thresholds that would trigger remedial action. They're also working to determine the appropriate actions to take if resistance is discovered.

Southern Insect Management Research Unit, Stoneville, MS

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Wasp cousins from Europe are reuniting in more areas of the northeast United States to control three native plant bugs. The alfalfa plant bug, tarnished plant bug and western tarnished plant bug are important pests of crops grown for seed in the western United States. Annually, they cost seed producers tens of millions of dollars in crop losses and controls. The toll is even higher for growers of cotton, fruit and vegetable crops pestered by the two tarnished plant bugs. Both of the beneficial wasps—*Peristenus digoneutis* and *P. conradi*—are native to Europe. A female *Peristenus* stings a young plant bug nymph, laying a tiny egg in it. A few days later, a wasp larva hatches and begins to eat the nymph, killing it in about a week. ARS imported both wasps about two decades ago and released them experimentally in northern New Jersey. From 1989 to the present, ARS led an interagency team to track the parasites' establishment and spread. This included surveying hundreds of fields, collecting plant bugs, and rearing and identifying parasites obtained from them. The studies determined that *P. digoneutis* became established in northern New Jersey by 1984 and spread to New York by 1989. Since then, scientists have found it in five additional northern states. Meanwhile, descendants of the released *P. conradi* wasps first turned up in Delaware in 1988. This wasp has since been found in New Jersey and New York and is likely to have spread even further.

*Beneficial Insects Research Laboratory, Newark, DE
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U.S. haygrowers can price their crop more competitively, thanks to an ARS-developed procedure that hastens Japan's inspection and approval of compressed bales exported to that country. Japan buys about \$240 million worth of U.S. hay every year to feed dairy cows, beef cattle and racehorses. But the Japanese want to keep out any Hessian flies that might lurk within the bales. Subjecting standard-size bales to 1,136 pounds of pressure per square inch compresses them to one-third their normal size. ARS scientists showed that compression alone killed 97 percent of laboratory-reared Hessian flies which were concealed—for the experiments—in bales of timothy, alfalfa, oat, bermudagrass or sudan grass hay. Fumigating bales with hydrogen phosphide for seven days at 68°F. provides an extra measure of pest control, they found. The scientists raised more than 630,000 Hessian flies for the tests. American growers started

using the procedure in 1997 to capture savings in reduced storage and freight costs.

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Plant Genetic Resources

Three new giant soybeans with multiple uses—for grazing, hay or silage over a wide geographic area—have been bred by ARS scientists. Derry, Donegal and Tyrone are the first improved forage-type soybean cultivars bred for animal feed. The varieties differ in maturity dates, disease resistance and in areas where they will grow best. Donegal is suited to the Northeast. Derry is ideal for the Midwest and Tyrone is best for the South. Work on the new soybeans began with crossing an old hay type with modern grain cultivars. Scientists later made selections for plant height, branching, lodging resistance, pod set and leafiness. The new plants grow 6 feet high and have exceptional vigor. In tests in several states through 1996, the forage soybeans produced over 6 tons of dry matter per acre—about 75 percent more than conventional soybeans. In tests in Maryland, Arkansas, Minnesota, Iowa, New York and Wisconsin, the new varieties ranked high in nutrient composition and quality. Last spring, seeds were shipped to 19 states from New York to Texas for performance testing. ARS has obtained plant variety protection for the new soybeans.

Weed Science Laboratory, Beltsville, MD
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A new high-yielding pinto bean that resists some of the crop's worst diseases will soon be available to growers. ARS and Washington State University scientists developed, tested and released the new pinto bean called Burke. In field tests at 40 locations in the Northwest, Burke outperformed eight other competing pinto lines from the national Cooperative Dry Bean Nursery collection. In tests in the Northern Great Plains, Burke's yields were up to 12 percent higher than two industry standards, Othello and Sierra. One reason: Burke is a cross between the two cultivars, so it possesses many desirable features of both. Burke resists several virulent fungi and viruses, including curly top virus, bean common mosaic virus and necrosis virus. When conditions are just right, the latter two can cause losses as high as 40 percent. Burke also resists key races of the rust fungus common in Michigan, North Dakota, Nebraska, eastern Colorado and other bean-

growing states. A fast, sprawling root system also enables Burke to withstand attack by soilborne fungi that cause root rots. Burke grows as a semi-erect plant and produces large pinto seeds that maintain their color, texture and taste during canning and storage. Scientists have applied for plant variety protection as Burke goes into commercial production this summer. This should help certify the cultivar's genetic purity.

Vegetable and Forage Crops Production Research, Prosser, WA

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Molecular Plant Pathology Laboratory, Beltsville, MD
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Breeders and nurseries who want more from their maples may want to catch the Red Rocket, a fiery-red maple cultivar just released by scientists with the U.S. National Arboretum. Also available: New World, an orange-red maple that is tailor-made for city landscaping. Both trees have resistance to cold and the maple leafhopper. For cold, New World can withstand temperatures as low as -30° F; Red Rocket can survive -40° F. Red Rocket's columnar shape and cold resistance make it an ideal line of defense against bad weather around barns, livestock shelters and park patios. New World branches up and out—a shape well-suited to growing along city streets in the northeastern United States. These new cultivars will be available in the retail markets in 2001.

Floral and Nursery Plants Research Unit, Glenn Dale, MD

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Human Nutrition

Bottle feeding by premature infants may be easier if they can control milk flow. Before premature infants can be bottle-fed, they must demonstrate they can use the bottle safely and efficiently. During bottle feeding, milk may flow too fast for some babies. As a result, it could get into airway, putting the baby at risk of choking. A recent study examined whether infants who are allowed to pace milk flow can better coordinate sucking, swallowing and breathing. This was achieved by holding the bottle so that the top of the milk is level with the baby's mouth. With this arrangement, premature infants fed 50 percent more efficiently than with bottles held at a steeper angle. This practice is used at Texas Children's Hospital for infants having feeding trouble. If further study confirms this benefit, it might be another way to assist infants who have difficulty feeding, especially low-birth-weight infants.

Children's Nutritional Research Center at Baylor College of Medicine, Houston, TX

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Vegetarians who include milk and eggs in their diets can meet their zinc requirements by eating plenty of whole grains and legumes such as beans and peas, researchers have found. The researchers studied 21 women who consumed both a lacto-ovo vegetarian diet—one containing milk and eggs but no other animal products—and a typical U.S. diet for 8 weeks each. Among its many functions, zinc helps the body guard against infections and repair wounds. In the U.S., however, meat is the major source of zinc. It's important to know if the nearly 2 million U.S. lacto-ovo vegetarians may be depriving themselves of adequate zinc, particularly since typical vegetarian diets contain 10 to 30 percent less zinc than non-vegetarian diets. They also contain a lot of fiber and phytate, which tend to reduce absorption of minerals such as zinc. In the study, the vegetarian diet supplied 14 percent less zinc despite efforts to include high-zinc foods. And the women absorbed 21 percent less zinc from the vegetarian diet, putting their absorption deficit at 35 percent. However, they absorbed enough to replace what they excreted, and their health remained good. In fact, the two diets produced very little difference in balance measurements—absorption minus excretion—for zinc and several other minerals. The women's iron status was also assessed, because the body

absorbs iron much more readily from animal foods than from plant foods. The women absorbed 70 percent less iron while eating the vegetarian diet, but they showed no signs of iron-poor blood after eight weeks.

Grand Forks Human Nutrition Research Center, Grand Forks, ND

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New findings dampen the prospect that levels of leptin, a hormone-like chemical signal in the body, may explain differences in body fat among people.

Scientists at an ARS-funded research center in Boston found no relationship between the amount of leptin circulating in the blood of 61 men and women and the total number of calories they burned each day or their metabolic rate while resting or after eating. The study volunteers ranged in age from 18 to 81 and none were obese. Leptin has become a hot area for obesity research since the discovery of a mutation in the mouse leptin gene that increases the animals' appetite while lowering their metabolic rate. But the researchers concluded that leptin doesn't influence energy regulation in adults by increasing their energy expenditure. In a study by others, young children with higher leptin levels reportedly burned more calories during physical activity. But the recent study indicates adults apparently lose their responsiveness to this signal.

Jean Mayer USDA Human Nutrition Research Center on Aging at Tufts, Boston, MA

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A native American grape could be a source of new health food products. The skin, pulp and seeds of muscadine grapes are loaded with resveratrol, ARS and Mississippi State University scientists have found. Resveratrol is the same compound in wines that is said to lower cholesterol levels and the risk of coronary heart disease. When purified from grapes, resveratrol has also been shown to inhibit tumor development. This research could help promote muscadines as an alternative crop for growers. About half of all muscadines now go into processing juice in the southeastern United States, where the grapes are primarily grown. Some of the remaining waste goes into low-value animal feed, while the rest pose an environmental disposal problem. But new healthy foods are being made from puree powder,

produced from the waste skin, pulp and seeds. Muscadine puree powder is higher in dietary fiber than oat or rice bran. Rats that ate the powder had significantly lower LDL (bad) cholesterol levels and higher HDL (good) levels than animals in a control group. One-half serving (2 fluid ounces) of unfiltered muscadine juice, one serving of muscadine jam, one medium muscadine muffin or one-tenth serving of muscadine sauce give the same dietary amounts of resveratrol as 4 fluid ounces of red wine. Muscadines' newly found health benefits could boost the growth of the grapes—especially since ARS research has reduced from 5 to 3 years the time needed to produce a commercial crop. *Small Fruit Research Laboratory, Poplarville, MS*
James Magee, (610) 795-8751, jmagee@ag.gov

Healthier ice cream? Sounds too good to be true, but it could become a reality, thanks to a new product that enhances the nutritional quality of low-fat foods. Nu-trim, a new product ARS scientists made from oat and barley flours, may help lower blood cholesterol levels in some people. Nu-trim contains a high concentration of beta glucan, a soluble gum found in oat and barley grains. Beta glucan may reduce blood cholesterol and may prevent it from attaching to blood vessel walls. Described as a "nutraceutical," Nu-trim is part of a new generation of food ingredients designed to boost a food's nutritional value without changing its taste and texture. Nu-trim is similar in texture to dairy and coconut cream, so it can replace fatty creams in baked goods, salad dressings, sauces and ice cream.

National Center for Agricultural Utilization Research, Peoria, IL
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A 3-month ARS study of the essential B-vitamin folate provides new evidence that its Recommended Dietary Allowance for women—180 micrograms a day—may be too low. Results from lab tests of 10 healthy women, age 49 to 63, who volunteered for the study suggest that higher levels of folate might be needed to prevent unhealthy buildup of the amino acid homocysteine or to forestall proliferation of white blood cell components called micronuclei. The micronuclei buildup is an indicator of DNA damage. Volunteers lived at the ARS research center in San Francisco for the experiment. They ate only foods specially prepared and precisely measured for folate content. Their low-folate regimen was followed by stints in

which they received 160 to nearly 300 percent of the RDA. The higher-folate phases help researchers assess how much folate—over and above the current RDA—is required for good health. Findings can be used by the panel of experts who set America's guidelines for folate intake. Good sources of folate include orange juice, liver, eggs, dark green leafy vegetables, peas, beans, nuts and seeds. In studies elsewhere, adequate folate has been linked to decreased risk of spina bifida, other birth defects, cardiovascular disease and stroke.

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New findings confirm that long-term use of vitamin C supplements substantially reduces the risk of cataract—a clouding of the eye's lens. Scientists at an ARS-funded center in Boston collaborated on the study with colleagues at Harvard University's Nurses Health Study. Among 247 women studied, those who took vitamin C supplements daily for more than 10 years had 77 percent fewer early-stage cataracts than those who didn't supplement. That's less than one-quarter as many clouded lenses. The women who took the supplements for less than a decade had no detectable difference in cataract prevalence. Supplement users took at least 300 milligrams of vitamin C daily in addition to food and multivitamin sources. The findings emphasize that cataracts take many years to develop and, therefore, require a long-term solution, the researchers say. They selected participants from Harvard University's Nurses Health Study, begun in the 1970s, based on high and low vitamin C intakes. None of the women had been previously diagnosed with cataracts. Each nurse had reported food and supplement intake several times before being examined for signs of lens clouding. A 1992 report from the larger nurses' study found that 10-plus years of taking vitamin C supplements was associated with far fewer cataract surgeries. Cataracts are thought to result from oxidation of lens proteins. Vitamin C appears to prevent this oxidation.

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Older people might reduce their risk of gaining weight by eating smaller, more frequent meals. The finding comes from a study comparing the fat-burning ability of eight women in their 20s with another eight in their 60s and 70s. The seniors kept pace with their juniors after eating 250- and 500-calorie meals. But they couldn't match the younger group's fat-burning rate after a 1,000-calorie meal. Fat oxidation was about 30 percent lower in the older women after the big meal. That's not good, because dietary fat that doesn't get burned gets stored as body fat. The researchers recommend that seniors eat fewer calories at a sitting, but eat more often to ensure getting enough nutrients. They also suggest older people exercise to increase skeletal muscle and fitness. This may offset the fat-burning deficiency. The study was the first to measure fat oxidation after eating. It was aimed at revealing underlying causes behind the age-related increase in body fat, which typically doubles between the ages of 20 and 50 to 60 years. The body fat increase is linked to several diseases, including cardiovascular disease and non-insulin-dependent diabetes. The findings support several studies that suggest a drop in fat oxidation plays a role. On average, U.S. women in their 60s and 70s consume about 1,400 to 1,500 calories a day. The researchers believe the drop in fat-burning ability is due to hormonal changes. The older women had higher levels of glucagon. This hormone triggers the release of sugar into the blood. With more sugar available to fuel body processes, the women burned less fat.

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Into the Marketplace

Three new natural products that are as effective as fungicides against two citrus diseases are being marketed in the United States, Central America and the Caribbean Basin. The products—KeyPlex 250-DP, 350-DP, and 445-DP—are effective against greasy spot (*Mycosphaerella citri*) and postbloom fruit drop (*Colletotrichum acutatum*). The KeyPlex products stem from a cooperative research and development agreement between ARS and Morse Enterprises Limited, Inc., Miami, FL. The original products were micronutrients

Contact the scientists listed for further information on each research project. For general questions about this report, contact Hank Becker, ARS Information, 6303 Ivy Lane, 4th Floor, Greenbelt, MD 20770, (301) 344-2769, hbecker@asrr.arsusda.gov

Items marked with the word PATENT are being patented by ARS. For more information on patents, CRADAs and patent licenses, contact ARS Office of Technology Transfer, Bldg. 005, Rm. 416, BARC-West, Beltsville, MD 20705, (301) 504-5734. Questions about a company's product and/or research should be directed to the company itself.

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to make plants healthier. ARS scientists added other naturally occurring compounds that increase plant resistance by causing them to produce more disease-fighting proteins. These start working when an outside enemy--like an insect or a disease-causing pathogen--invades the plant. Growers apply KeyPlex on citrus, bush beans and tomatoes and are testing it on limes, bananas, bell peppers and cotton. Future tests will include squash and other cucurbits, and the label list is being extended to include most vegetable and fruit crops. Since they're made from naturally occurring compounds, KeyPlex products don't require registration by the Environmental Protection Agency. The products don't kill pests, but enhance the plant's ability to repel them. *U.S. Horticultural Research Laboratory, Orlando, FL*
Richard T. Mayer, (407) 897-7300,
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Large, sweet, aromatic blackberries called "Triple Crown" may begin showing up in supermarkets within the next few years. This new ARS variety gets its name from its three crowning attributes: flavor, productivity and vigor. It ripens from about mid-July to about mid-August. Test plantings indicate it is well adapted to the Mid-Atlantic and Pacific Coast states. Researchers also expect Triple Crown to flourish in the lower Midwest and New England. Sakuma Brothers Farms, Inc., Burlington, WA, and Cedar Valley Nursery, Inc., Centralia, WA, offered Triple Crown plants for sale for the first time this spring. Indiana Berry & Plant Co., Huntingburg, IN, plans to sell Triple Crown this fall. In 1999, Nourse Farms, Inc., South Deerfield, MA, and Weeks Berry Nursery, Keizer, OR, expect to have a supply. ARS scientists tested Triple Crown, formerly known as US 1638, for a decade before releasing it in 1996. In Oregon trials, 8-year-old Triple Crown plants yielded an impressive 30 pounds or more of berries per plant. In ARS and Oregon State University tests, Triple Crown rated equal to the popular Chester Thornless and Marion blackberries in color, flavor and overall quality

for use in pies, preserves and other processed foods.
Fruit Laboratory, Beltsville, MD
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Homeowners, landscapers and others can create more visually exciting yards and landscapes with designer pine straw mulch now on the market.

Colored mulch is one of the latest advances in pine straw technology developed by ARS researchers. Recent ARS studies showed the colored mulch is environmentally safe and doesn't change soil pH. Pine straw is gaining in popularity as a mulch for landscaping projects. Adding colorants to pine straw enhances its attractiveness and marketability. Colored pine straw generates 30 to 50 percent more profit for farmers who harvest it. The colored mulch decomposes much more slowly than mulch without added color, making it more efficient and economical. Coloring pine straw and selling it as a mulch offers pine tree farmers another profitable use for this crop.

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Cooperative Research and Development Agreements

...With Protein Sciences Corp. of Meriden, CT, to produce poultry vaccines effective against avian influenza (AI). ARS worked with Protein Sciences on three vaccines against forms of AI, including one to guard against Hong Kong H5N1. When the Hong Kong AI outbreak occurred, Protein Sciences, with ARS scientists, responded by producing a vaccine that has been shown to be 100 percent effective at preventing death in chickens from the Hong Kong viruses. Scientists from the Hong Kong Department of Agriculture and Hong Kong zoo officials are testing the new vaccine's efficacy in chickens and other bird species there. The Protein Sciences vaccines are being evaluated for approval in the United States in case of another outbreak. An important advantage: When these vaccines are used, regulatory agencies can readily distinguish healthy vaccinated birds from those actually infected with disease-causing influenza.

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...With Bayer Corp., Watkinsville, GA, to find ways to prevent older hens from becoming infected with *Salmonella* during molting. Hens lay fewer eggs as they age. By temporarily feeding the aging birds a restricted diet, U.S. producers can induce molting in the birds and typically restore them to 85 percent of their original egg-producing capability. But the technique gives *Salmonella enteritidis* bacteria a fresh chance to take hold and contaminate the hens' eggs or chicks. European farmers are less likely to molt their birds, but *S. enteritidis* can still be a problem. To treat it, their veterinarians can prescribe Enrofloxacin. This drug is reinforced by another, Avigard, to prevent the bacteria's return. In the U.S., the drugs are approved to treat poultry for *E. coli*, but not *Salmonella*. ARS scientists are testing the effectiveness and safety of both drugs for *S. enteritidis* to see if the approach would work in the U.S. ARS scientists are also testing low-tech, natural ways to make molting safer. They've found that putting hens on a low-calcium, reduced-calorie diet instead of restricted feeding reduces *S. enteritidis* levels up to 100-fold.

Southeast Poultry Research Laboratory, Athens, GA
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...With Foss North America of Eden Prairie, MN, to refine an ARS-developed technique that is a faster and cleaner method for measuring saturated fat in meat. That's good news for companies complying with the food labeling laws on fat analysis as well as for health-conscious consumers who want to keep a close eye on their fat intake. It's also a plus for the environment, since current analysis methods use chemical reagents that pose a disposal problem. The scientists developed a non-chemical alternative--a technology called NIRS, or near-infrared spectroscopy. Near-infrared light waves are just beyond the visible part of the light spectrum. The NIRS approach can measure fat levels as low as 1 percent, well within the U.S. Food and Drug Administration requirements for precision. The NIRS measurements take less than two minutes, compared with chemical methods that take up to three days. Foss North America is an international supplier of automated rapid-analysis tools for the food and agriculture industries.

Quality Assurance Research Unit, Richard B. Russell
Research Center, Athens, GA
William Windham, (706) 546-3513, bobw@athens.net

...With Pioneer Hi-Bred International, Inc., Johnston, Iowa, and Mycogen Corp., San Diego, CA, to explore a gene called *cah* as a new tool in plant genetic engineering experiments. Tests by ARS researchers with wheat showed that the *cah* gene seems well suited as a marker that enables scientists to tell whether they've succeeded in moving new genes into a plant. Tests at Pioneer Hi-Bred and Mycogen Corp. may expand use of this promising marker to other crops. Marker genes can speed biotech experiments because they are usually easier and faster to detect--in experimental plants--than the useful gene with which they are paired. Useful genes might include ones that could boost the plant's nutritional value, bolster its resistance to attack by insects or disease, or give the plant other valuable new traits. ARS is seeking a patent for this use of the *cah* gene. (PATENT 08/873, 001) *Wheat, Sorghum, and Forage Research, Lincoln, NE*
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..With CRC Press, Boca Raton, FL, to publish a reference book on the world's economically important plants. The project stems from a revision of the former USDA Agricultural Handbook 505, *A Checklist of Names of 3,000 Vascular Plants of Economic Importance*. First published in 1977 and revised in 1986, the handbook has been a valuable reference on economically important plants to many scientists in agriculture. The new revision will provide essential reference data for about 8,500 plants of economic importance throughout the world. Each plant's entry includes the the plant's accepted scientific name, important synonyms, common names, economic uses and geographical distribution. The botanical and economic coverage will include plants or plant products that are traded, regulated or are otherwise directly or indirectly important to international commerce. The list includes plants with a negative economic impact, such as weeds and poisonous plants. Data for the revision comes from more than two decades of research by ARS plant taxonomists. The project arose from the need to provide accurate information on economically important plants to the Germplasm Resources Information Network (GRIN) of the USDA-ARS National Genetic Resources Program.

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Soil, Water and Air Quality

Byproducts from corn processing may help remove lead, copper, zinc and other heavy metals from industrial wastewater. ARS scientists developed a way to combine corn fiber and other corn products with citric acid to form a material that binds with heavy metals. The process could help industry safely treat heavy metal-laden wastewater. In the process, citric acid is heated to release hydrogen atoms from its molecules. Those molecules then bond readily with corn byproducts to form the material that will bind with heavy metals in wastewater. Stringent regulations require industry to remove heavy metals from wastewater before discharging the water. The new process is cheaper than petroleum-based products and uses corn, a renewable resource. The technology could also help farmers by increasing the value of corn and opening new markets for the crop.

National Center for Agricultural Utilization Research,
Peoria, IL

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Sunflowers can be a combination snow fence, wind barrier and cash crop in the normally fallow years between wheat crops in the central Great Plains. ARS researchers found that one key to getting the full benefit of sunflowers' wind protection and snow capturing is to set the combine's harvest head as high as possible, leaving the stalks about 30 inches tall. The standing stalks almost completely prevent soil from being blown away by spring winds that easily exceed 30 mph. The stalks also can trap three to 10 times more snow than would normally accumulate when no crop residues are present during blizzards common to the region. The trapped snow replenishes 3 to 9 inches of the soil moisture used by the growing sunflowers. This compensates for most of the water used by the thirsty sunflowers, making the practice worthwhile for farmers. They should earn more money than if they grew only wheat, even when yields of wheat or other rotated crops are lower because some of "their" water is used instead by sunflowers.

Central Great Plains Research Station, Akron, CO
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Irradiation could have potential as a safe new alternative for preventing water spinach, a tasty Asian plant, from posing a threat to Florida's Everglades. The plant is a popular iron-rich food in Asia, and many of Florida's Asian immigrants want fresh water spinach on their menu. But it's illegal to buy or sell fresh water spinach in Florida because if cuttings escape from farms or home gardens into Everglades tributaries, they can quickly crowd out native plants. Under a state certification program, some Florida farmers grow water spinach. But they may ship it only to markets outside the state. Recently, ARS scientists found a technique that could enable qualified farmers to grow and sell the crop inside the state and still protect the Everglades. The ARS scientists showed that harvested water spinach becomes unable to grow and spread when exposed to only 0.25 kiloGray of cobalt radiation. The Food and Drug Administration already allows up to 1 kiloGray of irradiation to delay ripening of fruits and vegetables. The new tactic would prevent unauthorized home-growers from starting their own crop and endangering the Everglades. But the approach must pass further research tests as well as state approvals. *Aquatic Weed Research, Fort Lauderdale, FL*
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Native desert grasses took 51 years to begin to re-establish themselves in a former grassland overrun by shrubs as a result of excessive grazing in the late 1800's and early 1900's. And fences to keep out grazing animals didn't help. This finding emerged from a 60-year-old-and-still-going study in southern New Mexico's Chihuahuan Desert. The long recovery time shows that management strategies followed through the 1980's need updating. These strategies included fencing and reseeding, with an assumption these would quickly spur a switch back to grassland. Shrubs have been periodically and selectively removed from certain study plots since 1938. These plots were fenced to keep out cattle, jack rabbits and other wildlife. But the fencing had no effect on the grasses' comeback. Repeated shrub removal and rainfall played roles, but very slowly. Only in 1989 did native desert grasses and other desirable plants start to show up in bare ground between shrubs. By 1995, the grasses were spreading throughout the bare areas. Long before, people had begun to doubt the grasses would ever return. ARS scientists are now

looking for new ways to manage shrublands and grasslands as the complex, fragile--though rugged-looking--ecosystems they are. They plan to target sites for remediation based on natural advantages they may possess, such as streams or springs.

Jornada Experimental Range, Las Cruces, NM
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ARS scientists have found that beneficial fungi are key to survival of fragile sagebrush seedlings planted to reclaim strip-mined rangeland in the West. The fungi, which dwell on roots, have hairlike filaments that funnel water and nutrients to the roots, thus extending their reach. Wyoming state law and federal reclamation regulations require replanting native vegetation such as Wyoming big sagebrush after mining. Mining companies typically salvage and store the topsoil--for as long as several years--and put it back only after they've finished mining a site. But when salvaged topsoil is stored that long, the root-helping fungi die off. For this reason, salvaged soil should be used within a few months on other sites in the area where mining activities have ended. Scientists conducted a greenhouse study using soil from a sagebrush-grassland site on a coal mine in northeastern Wyoming. Sagebrush seedlings grown in fresh topsoil with the fungi present lasted 3 to 5 days longer in dry soil. This could be just enough time to tide the seedlings over until the next rain. Ability to tolerate drought is critical to survival of plants in arid and semiarid lands of the West, especially in reclaimed soils that tend to hold less water.

Rangeland Resources Research Unit, Cheyenne, WY
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Fast-growing hybrid poplars may offer an environmentally friendly way to re-use leftover irrigation water that drains from irrigated farmlands. The trees could reduce the size and number of costly evaporation ponds needed today to collect saline drainage water. Because hybrid poplars can be harvested for everything from toothpicks and veneer to high-quality paper, they could also provide a new source of income for growers. Ecolotree, Inc., Iowa City, IA, provided six-inch cuttings for a test in California. When the test ended 5 months later, trees averaged 6 feet tall. Employing hybrid poplars to recycle water isn't a new idea, but the ARS study is apparently the first to scrutinize their ability to withstand chloride salt, boron

and selenium in amounts sometimes present in irrigation drainage. Of the eight kinds of hybrid poplars tested, none was as salt-tolerant as eucalyptus--another fast-growing species sometimes chosen for water re-use. But the market for poplar pulp and other wood products is stronger than that for eucalyptus. Findings should apply not only to California but also parts of Arizona, New Mexico, Colorado and Texas. Hybrid poplars might also help use up saline effluent from factories around the nation.

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Bluegill, bass and catfish now thrive in the South's silty, warm-water streams. Weekend anglers may be glad to hear that "sticks and stones" can protect those waters--and their fish--for generations to come. The sticks are dormant willow posts planted in eroding streambanks. These cuttings come to life in spring and grow branches and roots to protect the streambank from erosion. The posts can range from 7 to 20 feet long. The stones are quarried stone structures of six to eight inches in diameter--"fingers" set perpendicular to the current, or "toes" set parallel to the bank--that put a brake on speeding currents that can erode stream banks. Scientists conducted a 3-year study to determine which technique--stones or sticks--is most effective in restoring fish habitats in a stream damaged by extreme erosion. Stone treatments seem slightly better based on the size of fish. But they are more expensive. Willows cost only a fraction as much as stone treatments and--while they may die off--living or dead they create habitat for other wildlife.

National Sedimentation Lab, Water Quality and

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Food Safety and Quality

New pastas or cookies that melt in your mouth like butter are a step closer, thanks to a key discovery about wheat proteins. ARS scientists identified the molecular basis for one of wheat's most important qualities: texture, known as hardness or softness.

Bakers use hard wheats to make bread and soft wheats for cookies and cakes. Scientists have known since the 1970's that one gene controls wheat texture. It directs wheat kernel cells to make proteins called puroindolines. Until now, scientists haven't understood the relationship between puroindolines and hardness. But ARS researchers found that specific types of puroindolines (known as pinA and pinB) correlate perfectly with wheat texture. All soft wheats, including wheat's wild ancestors, have pinA and a certain form of pinB. This pinB has glycine as the 46th amino acid in the protein. The scientists tested more than 200 North American hard wheats. Most differ from soft wheat by a single amino acid, serine, as the 46th amino acid in pinB. All the other hard wheats have the glycine pinB but don't have pinA. Breeders can use this information to develop custom-designed varieties with specific puroindoline combinations, using either traditional breeding or biotechnology.

Western Wheat Quality Laboratory, Pullman, WA

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A new batter being developed by ARS researchers could reduce the oil in fried chicken, fish and other foods that otherwise add fat to consumer diets. The new batter is made from rice flour rather than wheat and absorbs 60 percent less oil when fried. The difference is in the chemical constituents of the two grains. Wheat flour, the chief ingredient in standard commercial batters, helps give fried chicken its moist, golden coat and mouth-watering flavor. But gluten, an important wheat flour protein, binds tightly with oil, so more is absorbed into food. That's less of a problem with the rice-based batters, thanks to the grain's different proteins, starch and other components. Initially, scientists noticed that the rice batter didn't properly fluff up and stick to chicken meat. But they overcame the problem by first modifying the rice with several processing techniques. They are now collaborating with A and B Ingredients of Fairview, NJ, to explore the batter's commercial potential as a low-oil product for the food industry and health-conscious consumers.

Southern Regional Research Center, New Orleans, LA

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Tortilla chips fried in a monounsaturated vegetable oil produced by new sunflowers stayed fresh tasting longer than chips fried in commercial sunflower oil.

The new sunflower hybrids are called NuSun. ARS food technologists say NuSun oil has a more favorable balance of fatty acids--several times more oleic acid than traditional sunflower oil and less than half as much linoleic acid. Some studies have indicated that in moderately low fat diets, a high proportion of fat such as oleic acid can lower serum cholesterol and the risk of coronary heart disease. With its lowered linolenic acid content, NuSun oil holds up well in frying vats, even without hydrogenation, a chemical process that stabilizes oils. In field tests, ARS geneticists have shown commercial and experimental NuSun hybrids equal traditional sunflower varieties in agronomic qualities such as yield potential. The researchers also found that a single dominant gene ensures any number of such hybrids can be bred to produce oil ranging from 60 to 75 percent oleic acid. This year, for the first time, NuSun is being grown on some 100,000 acres. According to industry officials, the new hybrids could well provide an impetus for doubling U.S. acreage of oilseed sunflowers from its present 2.2 million acres by 2001.

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***E. coli* bacteria that have been subjected to only a sublethal dose of heat can become more heat-resistant than bacteria that have not been exposed to such heat, ARS scientists have found.** This means cooking regimens designed to kill these deadly bacteria must be based on the pathogen being in its most heat-resistant state. Pathogens previously subjected to lower heating temperatures are tougher to kill, so it's vital to adequately cook food to kill food-borne pathogenic bacteria. In tests, ARS scientists heated beef gravy samples contaminated with *E. coli* 0157:H7 to 114.8°F for 15 to 30 minutes. The heat did not kill the bacteria, but stimulated it so that it could adapt to the stressful heating conditions. The scientists then cooked the gravy to a final internal temperature of 140°F, killing the bacteria. Preheated *E. coli* survived longer--with a 1.5-fold increase in heat resistance--than other *E. coli* not subjected to the sublethal heat treatment. Food

processors should take note that slowly heating foods to the final cooking temperatures normally used won't kill bacteria. Heat-shocking conditions may occur in minimally processed, refrigerated, cook-in-the-bag foods such as beef stew, roasts, and soups. Induced heat resistance could also be a concern in meat products kept on warming trays before final heating or reheating. Adequate cooking remains the primary means to kill pathogens in food.

Eastern Regional Research Center, Wyndmoor, PA
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Several compounds in corn inhibit *Aspergillus flavus* fungi from producing aflatoxin. Among the compounds are alpha-carotene and other carotenoids that impart yellow color to modern corn hybrids. Scientists pinpointed the compounds with a new test they've developed that extracts aflatoxin from fungus cultures. The new procedure requires less extraction solvent, takes less time than previous tests, and works with samples of 1 milligram or less. In experiments, the scientists extracted aflatoxin from cultures containing compounds identical to ones found in corn. They found that *A. flavus* cultures grown in the presence of inhibitory compounds such as alpha-carotene contained significantly less aflatoxin. *A. flavus* thrives in the corn kernel's oil-rich germ and produces a majority of aflatoxin in this part of the kernel. Not surprisingly, the aflatoxin-inhibiting compounds occur more heavily in other parts of the kernel. The researchers hope their work will lead to genetically engineered corn lines that produce ample amounts of inhibitory compounds in the germ. Corn with more than 20 parts per billion of aflatoxin--equal to just 1 ounce in 3,125 tons--is deemed unfit to feed animals that produce meat or milk for humans. *National Center for Agricultural Utilization Research, Peoria, IL*
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Texture, or firmness, is vitally important to the quality and shelf life of produce. ARS scientists have cloned part of a gene responsible for making an enzyme that breaks down the cell wall in tomatoes, causing softening and other texture changes that lead to decay. Enzymes cause several changes in cell walls as tomatoes ripen; these enzymes include a group called beta-galactosidases. ARS scientists identified and cloned a family of seven beta-galactosidase genes in tomatoes,

including one that degrades cell walls. Two research groups in Great Britain are collaborating on studies to understand the gene's role in fruit softening. Transgenic plants carrying the cloned gene are expected in a year. *Horticultural Crops Quality Laboratory, Beltsville, MD*

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Animal Production and Protection

The first preclinical, noninvasive test for scrapie, a fatal brain disease of sheep and goats, should be available in a few years, thanks to ARS research.

Reliable diagnosis of scrapie is the first step to eradicating the disease, which would greatly improve U.S. sheep and goat export opportunities. ARS scientists discovered that the nictitating membrane, or third eyelid, in sheep collects proteins known as prions. Abnormal prions are the infectious agents believed to cause scrapie. Until now, scrapie could be confirmed only by examining the brains of dead animals. The researchers also developed a new laboratory-built molecule, called a monoclonal antibody, that detects the presence of the abnormal prions. The test will eventually allow veterinarians to detect scrapie before animals show clinical signs. Only a local anesthetic is needed to sample the eyelid tissue, so the procedure will be inexpensive and safe. ARS has applied for a patent on the test. (PATENT APPLICATION 08/950,271)

Animal Diseases Research Unit, Pullman, WA
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New tests to accurately diagnose and identify all known strains of *Chlamydia* bacteria that infect birds, humans and other mammals have been developed by ARS researchers. In humans, *Chlamydia* cause sexually transmitted diseases, respiratory disease and eye infection leading to blindness. In animals, the bacteria cause respiratory disease, conjunctivitis, arthritis, enteritis and reproductive failure. In birds, chlamydial infection results in lethargy and sometimes death. Until now, the only way to study these bacteria has been in cell cultures or fertilized chicken eggs. The four DNA-based tests use polymerase chain reaction (PCR) to target genetic material found in all chlamydial strains. One of the tests takes only about 4 hours, compared to 2 to 4 days needed by current culturing

methods. The new tests will help veterinarians diagnose and improve treatment for sick birds and animals. Most important: They will shed light on how people and animals become infected. ARS is pursuing patents on these tests.

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An intestinal parasite that feeds on the blood of sheep, cattle and other ruminant animals could become its own worst enemy. That's if ARS researchers can exploit important biochemicals in the parasite's own gut that help it digest red blood cells. One possibility: a vaccine that could help "jump-start" the immune system of susceptible or young animals, like lambs or calves. Currently, anthelmintic drugs are the weapon of choice against the parasite, the nematode *Haemonchus contortus*. Also called the barberpole worm, *H. contortus* belongs to a genus that costs cattle and sheep producers millions of dollars in losses and control measures. The barberpole causes bleeding in its host's stomach walls, then feeds on the blood. Severe infections can kill an animal or cause poor milk, meat, hide or wool production. The worm mainly derives its nutrition from hemoglobin in red blood cells it ingests. Scientists recently found several key proteins and enzymes that help the barberpole utilize these nutrients. One protein group, called hemolytic factors, ruptures the red blood cells. This causes hemoglobin to seep out into the barberpole's digestive system. In test tube studies, the hemolytic proteins completely destroyed sheep red blood cells within 90 minutes after exposure.

Researchers want to purify the proteins so their chemical structures can be ascertained. This raises the prospect for developing antibodies to help animals stave off nematode infection and ease the need for anthelmintic drugs.

Parasite Biology and Epidemiology Laboratory, Beltsville, MD
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A high-tech molecule called a bifunctional antibody may give cows a natural way to fight mastitis, an infection of the mammary gland. The first of these antibodies for farm animals has been built by an ARS researcher with help from researchers at the National

Institute for Agronomic Research in Nouzilly, France, and the National Cancer Institute in Bethesda, MD. Mastitis costs the U.S. dairy industry more than \$2 billion annually. A producer with 100 cows can expect some 50 to 80 cases of mastitis each year. Antibiotics are often ineffective. Producers can't sell milk from treated cows for a few days. To find a more natural alternative, the ARS scientist turned to the bifunctional, or coupled, antibodies. One end of the new antibody hooks to the mastitis-causing bacterium, *Staphylococcus aureus*. The other end snags its "terminator," a neutrophil--a specialized white blood cell from the cow's immune system. This triggers the neutrophil to release a lethal spray of hydrogen peroxide. The spray can't miss, since neutrophil and bacterium are "handcuffed" together by the antibody. It could take several years to ready the technology. Scientists must first prove bifunctional antibodies adequately boost the neutrophils' killing power. Then they will have to refine the technology for its most effective use by dairy producers. *Immunology and Disease Resistance Laboratory, Beltsville, MD*

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Newborn piglets respond to infection with unusual and possibly harmful changes in body temperature, while older piglets quickly develop a mild fever, one of the body's natural defenses against disease. In a laboratory maintained at about 64° F, scientists injected 1- to 28-day-old piglets with a component of killed bacteria to simulate infection by a live disease organism. Piglets 21 to 28 days of age produced fever within an hour, in contrast to newborns that developed hypothermia--reduced body temperature. This underscores the very young piglets' need for a warm environment. Further research may explain why newborn pigs with simulated or real infection develop hypothermia. An understanding of the physiological mechanisms may help scientists find ways to improve growth and reduce sickness and death among young pigs. About 12 to 15 percent of piglets now die before weaning.

Animal Physiology Research, Columbia, MO
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A new oral vaccine that protects cattle against the pneumonia-causing bacterium *Pasteurella*

haemolytica has been designed by ARS researchers. Pneumonia costs U.S. and Canadian cattle producers more than \$1 billion each year. In laboratory and field tests, the genetically engineered vaccine--administered in feed--provided 100 percent protection for calves. In a field test of 100 calves, none of the vaccinated calves died while 10 unvaccinated calves died from pneumonia. Shipping fever, as this respiratory disease is more commonly known, affects animals about one week after they are transported from the cow and calf operations where they were born to the feedlots where they finish their growth. An added bonus: Vaccinating calves via feed rather than by intramuscular injection is less stressful for animals and less time consuming for producers. This research was supported by the Biotechnology Research and Development Corporation. *National Animal Disease Center, Ames, IA*
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Human Nutrition

A type of soybean oil high in oleic acid--a heart-friendly mono-unsaturated fatty acid--may find its way to the breakfast table in a new margarine being developed by ARS scientists. The new table spread uses oil from soybean varieties specially bred to produce higher levels of oleic acid, which has been shown to reduce cholesterol levels in some humans. ARS scientists are examining new ways to use these oils using a process called interesterification, a process which rearranges the fatty esters on the glycerol molecule. This process changes the chemistry of the oil and makes it a better component of margarine. Without interesterification, the oils would separate and the margarine would become soft and unspreadable. Interesterification also discourages the formation of trans-fatty acids, which some studies show may slightly raise cholesterol levels in humans.

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A reliable and painless early warning system for colorectal cancer may soon be available. That's in large part because an ARS chemist developed a method for isolating live colon cells from stool samples. Colon cancer causes about 14 percent of all cancer-related

deaths in the U.S. It begins as abnormal growths, or polyps, 3 to 5 years before a malignancy appears. The current noninvasive screening method checks for blood in fecal smears. But it is plagued with false positives and false negatives. And a true positive reading means the tumor is fairly advanced. A technique that detects the polyp stage would give physicians ample time to remove growths before they turn cancerous. This would also give patients an opportunity to correct dietary habits that may contribute to cancer risk. Working with a physician at Sinai Hospital of Baltimore, the ARS chemist found that CD44--the tell-tale marker reported on other types of cancer cells--also appears on the surface of isolated colon cells. Recently, Japanese researchers reported that variants of CD44 appear on isolated colon cells of colorectal cancer patients far more frequently than on cells from people without tumors or on patients' cells after surgery. As more such markers and gene mutations signaling abnormal cell changes emerge, screening of isolated colon cells may become routine in as few as 5 years, the ARS and Sinai scientists suggest. It is already one of the first molecular biology assays to be evaluated in a clinical setting.

Beltsville Human Nutrition Research Center, Beltsville, MD

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An expectant mother's water-weight gain--vital to fetal growth and delivery of a healthy, normal-weight infant--might be easier to monitor with a safe, fast and painless technique called bioimpedance spectroscopy. Scientists with ARS, the University of California at Berkeley and Xitron Technologies, Inc., found that bioimpedance measurements of 10 women taken before, during and after pregnancy correlated significantly with infant birth weight. Low-birth-weight babies--those weighing less than 5-1/2 pounds at birth--have a higher risk of early health problems. The study is apparently the first to indicate that the impedance technique may offer a convenient, inexpensive way for physicians to detect subnormal water-weight gains in time to help expectant mothers take corrective action. The technique requires sending a current--a harmless range of consecutive electrical frequencies--between electrodes placed on the hand and foot, then using a computer to calculate water content or "total body water."

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Francisco, CA

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A popular belief--that dietary fat increases people's calorie intake--lost credibility in an ARS study of identical twins. On average, the seven sets of male twins chose about the same number of calories from either of the two diets they were offered. One diet contained 20 percent fat calories; the other, 40 percent fat. Both diets had about the same palatability, fiber content and number of calories per ounce of food--factors that may affect total calorie intake. Four sets of twins ate more calories from the high-fat menu. The other three pairs preferred the low-fat diet. This suggests fat content is not the dominant influence on calorie intake; calories per ounce of food may be more important. This supports some earlier, short-term studies. The findings also suggest that genes exert some control over a person's preference for a high- or low-fat diet. The research may help explain why the U.S. population has added weight during a time when fat intake has dropped and thousands of low-fat and fat-free products have hit the market. Designed to taste good, many such products are high in calories.

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Crop Productivity

Planting soybeans earlier to synchronize with rainfall can boost crop yields, avoid drought and produce an earlier harvest. Midsouth growers usually plant their soybeans in May and June. But ARS scientists have developed an Early Soybean Production System (ESPS) in which farmers can plant early-maturing soybean varieties in April. The early planting means the soybean plants will be going through their reproductive stage--when their water demands are especially high--during the high-rainfall season from April through June. Drought is common in the Midsouth region later in the growing season from July through early September. That means plants sown on the conventional timetable develop pods and seeds and fill these seeds during hot, dry months when water is scarce. In a 3-year field study, ESPS beans planted outperformed conventional soybean

plantings. Since ESPS plants will be harvested earlier than those planted in the conventional system, growers may benefit from a higher price received for their early delivery. Researchers say ESPS should allow soybeans to avoid late-season, foliage-feeding insects. That's because by then, the plants have matured and are less susceptible to insect damage. Soybean yields have remained about the same for 30 years mainly because of dry spells in the growing season. But farmers may change that--and boost their profits--by planting an earlier crop.

Soybean Research Unit, Stoneville, MS

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A gene-transfer system designed by ARS scientists could result in garlic and onion plants with new desirable traits for home and commercial gardens. Using a gene gun, the researchers transferred bacterial genes into garlic, the first step toward introducing beneficial traits such as virus resistance. These benign genes were integrated into the garlic chromosomes and were still present in 16-month-old plants. The researchers are now planning to "blast" garlic plants with useful genes for traits such as resistance to onion yellow dwarf virus. Each year this pathogen reduces yields by 30 to 50 percent in infected garlic plants--a serious loss to growers worldwide. Commonly grown garlic varieties are highly susceptible to onion yellow dwarf virus. Scientists have come up with techniques for introducing foreign genes into many crops, but this is the first system that shows promise for garlic and onions.

Vegetable Crops Research, Madison, WI

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Sunflower growers could boost pollination of their crop by also growing some canola, ARS scientists report. High yields depend on having the healthiest, most effective pollinators possible. But while sunflower pollen is a favorite of the hardworking domestic honey bee, the scientists found that it doesn't provide enough protein to keep the insects healthy. Undernourished bees lose strength and may not do a good job in any crops they're "hired" to pollinate. The scientists found that sunflower growers can help bees get the mix of pollen-derived nutrients they need by planting small areas of other crops such as canola (also known as rape) near sunflower fields. Tests showed canola pollen is higher

in protein than pollen from sunflower and sesame. Results from monitoring 125 honey bees in indoor cages showed that bees fed canola pollen lived 48 to 65 percent longer than those fed sesame or sunflower pollens. Researchers chose these crops because their planted acreages are increasing.

Carl Hayden Bee Research Center, Tucson, AZ

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Seeds of winterfat, an important shrub for livestock and wildlife, are even more freeze tolerant than scientists have suspected. The discovery can help land managers--and someday, perhaps, breeders of a variety of crops. In ARS studies in Wyoming, soaking-wet seed embryos of winterfat survived temperatures as low as minus 22° F. The seeds can survive even when they contain large ice crystals. A study of seeds from Colorado, Wyoming and Saskatchewan, Canada, showed that the colder the temperature at which the seeds were soaked, the better they survived subsequent freezing. But seedling vigor varied by where the seeds were collected. This indicates that those interested in planting winterfat in areas with harsh winters should look for local sources of winterfat seed. If scientists uncover the reason for winterfat's freeze tolerance, breeders might have a new approach for gene-engineering crops such as corn, soybeans and lettuce for improved freeze tolerance. The scientists soaked and froze the seeds to simulate typical early-spring cycles of thawing and freezing in the Northern Great Plains and other parts of the West. Their next step: taking a closer look at super-chilled winterfat seeds under an electron microscope. This could determine whether--as the scientists suspect--winterfat seed survives extreme cold because ice crystals form first in the outer, hairy layers of its fuzzy covering. If so, the crystals could "suck" water from the embryo, protecting it from severe ice damage.

High Plains Grasslands Research Station, Cheyenne, WY

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Flax plants don't easily give up their soft white fiber, known as linen. Like bricks, carbohydrates called pectin hold the fiber firmly inside the plant stem. The pectin "bricks" are cemented together by calcium. An ARS scientist and collaborators found a chemical that breaks down the calcium so an enzyme, developed by

Novo Nordisk, of Bagsvaerd, Denmark, can more easily reach the flax fiber. This means less enzyme is needed in fiber extraction, reducing costs. The research might bring alternatives to dew-retting--leaving the flax in the field to allow dampness to loosen the fiber. The U.S. imports up to 7 million pounds of the raw fiber every year from Asia and Europe, but domestic flax production ended with World War II tent-making efforts. Efficient alternatives to dew-retting could help bring back domestic flax production.

Richard B. Russell Agricultural Research Center, Athens, GA

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IPM/Biological Control

Reining in the Formosan subterranean termite, an East Asian pest now established in 13 states, is the goal of a new ARS-led national campaign. Scientists suspect the termite entered the United States via supply ships shortly after World War II. But it wasn't until the late 1960's that scientists detected it in New Orleans and other southern port cities. Today, the wood-eating pest costs \$1 billion annually in repairs and control measures. A U.S. Environmental Protection Agency ban in the late 1980's of potent chemicals called organochlorines has exacerbated the problem. The ban stemmed from concerns over toxic residues posing a danger to human and environmental health. Scientists fear the Formosan subterranean termite will continue its spread. ARS researchers in New Orleans are coordinating a large counterattack called "Operation Full Stop." It includes experts from other ARS labs, the New Orleans Mosquito and Termite Control Board, the Audubon Institute and collaborating universities such as Louisiana State University. They'll employ an arsenal of weapons to reduce the termite's numbers and its colonies. These include slow-acting toxic baits, computerized maps, growth-regulating compounds and biocontrol agents such as predatory insects and fungi. The campaign began in New Orleans but will eventually expand to other infested cities and states.

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Newly isolated genes that produce protective proteins in plants are now in gene banks for public use. ARS scientists worked for 6 years to identify and purify these

plant protective proteins in citrus. These proteins help plants defend themselves by warding off attacks by pests or disease. Although many plants already have genes that produce protective compounds, it would be useful to have transgenic plants express the compounds in larger quantities or at a different place in the plant at a different time. With funds from a self-imposed grower tax, the Florida Citrus Production Research Advisory Council supports ARS research to study plant defenses. If plants can better defend themselves, growers will spend less on fungicides and insecticides, also benefitting the environment.

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New microencapsulation technology could help viruses, bacteria and other environmentally friendly biopesticides compete with traditional chemicals. Into cornstarch that was heated, or partially gelatinized, scientists mixed microbes such as the bacterium *Bacillus thuringiensis* (Bt) or baculoviruses--a group of viruses that cause disease in caterpillars. When the mixture was added to water and dried, the microbes became entrapped in tiny particles that could be resuspended in water and sprayed on crops. Until now, marketing encapsulated biopesticide technology has been impeded because there was no single formulation appropriate for different crops and field-spraying equipment. The amount of ingredients such as sun protectants added to boost a formulation's effectiveness depended on how much water was needed for the mix. With the new technology these ingredients, called adjuvants, are mixed into formulations as they are manufactured. The adjuvants are uniformly bonded with starch and the biopesticide and remain in a stable blend throughout conventional tank mixing and application.

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A device used to quickly separate dirt, sticks and stems from farm seeds may simplify and cut the cost of another job--insectary mass-rearing of beneficial wasps for outdoor biological control assignments. The helpful wasps, harmless to humans, parasitize crop pests such as the Mediterranean fruit fly. Medfly can attack more than 400 different crops worldwide. ARS researchers in Hawaii showed that a seed-sorting

pneumatic air separator can quickly sort immature fruit flies that harbor a living wasp from those that do not. The sorting can be done when the fruit fly is still inside its pupal case and resembles a tightly rolled, dried-up leaf. The wasp develops inside the fruit fly pupa, eventually kills it, and then emerges from the pupal case. When released outdoors, adult female wasps parasitize new fruit fly victims by injecting eggs into the hapless pupae. In tests with about 150,000 pupae of medfly, oriental fruit fly and melon fly, researchers showed that the separator's airstream lifts lighter, parasitized fruit fly pupae into an upper tray, while denser, unparasitized pupae drop into a lower tray. Scientists used three different species of beneficial wasps in the tests.

Tropical Fruit, Vegetable, and Ornamental Crop Research Laboratory, Hilo, HI

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Controlling Cape ivy, a weed rapidly taking over natural areas along the west coast of the U.S., is the goal of a new cooperative project between ARS and South African scientists. The vine was introduced from South Africa as an ornamental plant before the turn of the century. Now it has spread into wild areas throughout coastal California and into Oregon, where there are no natural enemies to curb the weed's growth. Cape ivy reduces native plant diversity and precious habitat that endangered plants and animals need. Chemical weed killer is frequently not a control option because the weed grows in hard-to-reach areas, near water and in areas that contain sensitive species. The researchers hope to implement a biological control solution. The Pretoria scientists began searching this spring along the east coast of South Africa for insects and pathogens that appear to control the ivy naturally. The researchers believe such biocontrols exist because Cape ivy is uncommon in its homeland, suggesting that natural enemies keep it in check. Once potential biological agents are found, ARS will test them for safety on native U.S. plants. Ultimately, if an effective biocontrol is identified, ARS will apply for permission to release the insect or pathogen.

Plant Protection Research Unit, Albany, CA

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A new genetic fingerprinting technique could be sweet news for sugarcane growers looking for ways to put the brakes on ratoon stunting disease (RSD) in sugarcane. ARS researchers devised the technique to

help growers avoid planting fields with seedpieces or cuttings infected by *Clavibacter xyli* subsp. *xyli*, the bacterium that causes RSD. Key to the approach is polymerase chain reaction, or PCR. It locks onto specific bacterial genes in infected plant samples and then mass-produces the genes so they can be identified or fingerprinted. If the sample is clean, no chain reaction occurs. The RSD bacterium is responsible for one of the most serious diseases of sugarcane in Florida and Louisiana, where much of the nation's \$1.5 billion crop is grown. Severe outbreaks can cause a 50 percent drop in a crop's sucrose yield. This usually happens in the second or ratoon crop, where plants grown from cuttings of a previous harvest lose their vigor and reach half their normal height. RSD doesn't produce any visible symptoms other than stunted growth, so the new diagnostic test should prove handy to growers who currently have no way of knowing their crop is infected until late in the season.

Sugarcane Research Unit, Southern Regional Research Center, New Orleans, LA

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Two recent advances could reduce citrus-growing risks. In certain citrus varieties, ARS scientists have identified a gene that appears to give the plants resistance to *Phytophthora*, a devastating fungal pathogen that causes foot rot. Most of the best citrus varieties are sweet oranges whose roots are highly susceptible to foot rot, so they must be grafted and grown on more resistant rootstocks. Many commercial rootstocks are also very susceptible to *Phytophthora*. Rootstocks are used to increase yield, tolerance to different soil types and resistance to other diseases. The research goal: put the newly isolated gene into a sweet orange like Valencia to see if it can be grown on its own roots and still resist *Phytophthora*. Meanwhile, the researchers have also identified proteins that disrupt feeding of the West Indies sugarcane rootstalk borer weevil. This pest teams up with *Phytophthora* to land a powerful one-two punch on citrus. Weevil larvae feed on roots, causing plant decline and death. Injured roots are more susceptible to *Phytophthora*. The newly identified proteins not only block certain key enzymes the weevil larvae need to break down plant cells, but they also work well on fungal pathogen enzymes. Researchers are looking into ways the proteins can be used to control the weevil.

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Harvesting potato vines as cattle feed reduces pesticide and herbicide applications on potatoes.

Potato vines are normally killed with herbicides about 2 weeks before the potatoes are harvested. This prevents the leftover vines from providing a home to insects and plant diseases that could harm the next year's crop. Now, ARS and University of Wisconsin scientists have found a way to harvest and store the vines and use them as cattle feed. They say potato vines can be turned into silage in combination with other crops such as chopped alfalfa, barley or entire corn plants to produce a high-protein, low-fiber cattle feed. The savings for U.S. potato growers could be as much as \$42 million annually.

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A new sprayer and natural plant compounds could give growers better control over destructive silverleaf whiteflies and other soft-bodied pests.

The whiteflies suck sap from leaves of more than 600 fruit, vegetable, fiber and ornamental plants. Plus, their saliva transmits plant diseases. The pests tend to cluster on undersides of leaves where insecticide spray doesn't reach very well. ARS scientists recently evaluated an ultrasonic fogger that delivers low dosages of insecticides in droplets that coat the top and bottom of the leaf. In tests, the fogger used far less insecticide but still killed a high percentage of whiteflies infesting collard plants.

The scientists also screened 21 species of a wild tobacco plant, *Nicotiana*, for their commercial potential as sources of natural insecticidal compounds. The compounds, known as sugar esters, break down a soft-bodied insect's "skin" and cause the pest to dehydrate. The scientists found that the best commercial candidate overall was *Nicotiana trigonophylla*. Its esters are the least complex, are very concentrated and are comparatively easy to extract from the plant.

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Goats might help stop the spread of tall whitetop, a weed that has cropped up in nearly every western

state. The plant is also well established in New England. An ARS grazing experiment in Nevada with 13 young goats showed that the animals, fenced in a tall-whitetop-infested meadow, ate the white-flowered weed with no ill effects. That's important, because scientists aren't completely certain whether the plant is poisonous to animals. Ranchers and land managers today have no fast, effective way to fight the aggressive weed. Cattle and sheep graze tall whitetop, also known as perennial pepperweed, but won't tackle pure, dense stands of it. The goats, however, grazed thick stands along with regrowth from those stands and from mowed stands. They ate about 75 percent of the young, tender, more digestible regrowth, compared to about half the vegetation in older stands. Scientists are following up with another Nevada test, using about two dozen goats. Their ARS colleagues in Utah plan to use sheep in new tests of toxicity.

Ecology of Temperate Desert Rangelands Research,
Reno, NV

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Poisonous Plant Research Laboratory, Logan, UT
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Plant Genetic Resources

'Sunburst,' a new ornamental sunflower, is the 600,000th plant to enter the gene banks of the U.S. National Plant Germplasm System (NPGS). This network of federal, state and private organizations and people work to preserve genetic diversity of agricultural and horticultural crops and their wild relatives. Sunburst also is valuable for breeding new oil-producing sunflower hybrids for farmers. The plants grow about 36 inches high and produce profuse yellow flowers. The main flower head is about 4 inches in diameter with branches producing several heads about 2 to 3 inches in diameter. Sunburst was developed by ARS researchers in Fargo, ND, in cooperation with the North Dakota Agricultural Experiment Station. Sunflowers are the most valuable native plants grown as a food crop in the U.S. In 1997, 2.9 million acres of U.S. sunflowers produced 3.76 billion pounds of seed and 1.05 billion pounds of oil. Limited quantities of Sunburst seed are available through the NPGS and the ARS laboratory in Fargo.

National Germplasm Resources Laboratory, Beltsville, MD

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Northern Crop Science Laboratory, Fargo, ND

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The latest laboratory techniques in plant breeding are being used to cross wild South American petunia plants with North American standard varieties.

Some of the offspring may one day emerge as new varieties with flower colors not seen in today's petunias, such as fire-engine red and pastel. The new petunias would also offer alternatives to the strong scent and hairy leaves of current varieties. ARS researchers are monitoring results of 200 different crosses. Traditional petunia breeding is hampered because genes for unwanted traits--like hairiness--reside next to desirable ones. Instead, ARS researchers use genetic analysis to pinpoint potential petunia "bloodlines." They're using germplasm obtained by a breeder who traveled to South America in search of petunia specimens with new or rare traits. Brazil's mountains yielded cold-tolerant petunias growing in the snow. A giant petunia shrub with big milky blossoms came from Ecuador. Other imports include a new drought-tolerant, smooth-leaved petunia species gracing the beaches of the Torres Coast in Brazil.

ARS Floral and Nursery Plants Research Unit, U.S.

National Arboretum, Beltsville, MD

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Siskiyou blackberry plants, newly named and released from ARS in cooperation with Oregon State University, yield sweet, shiny, pleasantly firm berries.

Siskiyou ripens early in the fresh-market season, from about mid-June through the third week of July. The berries are large, averaging approximately 1-1/2 to 1-3/4 inches long and about 1 inch in diameter. That makes them nearly as big as the jumbo "Black Butte" blackberry recently released by the same researchers. Vigorous and disease-resistant, Siskiyou is intended for commercial growers, pick-your-own operators and backyard gardeners. Berry farmers who planted Siskiyou when it was known only by its research designation, ORUS 830-4, already command a premium price in the early-season fresh market for the flavorful fruit. Siskiyou resulted from more than a decade of research trials. It does well in California, Oregon, Washington, and Canada's province of British

Columbia. And, based on its good performance in research plantings in North Carolina, scientists say it is worth testing in other southeastern states. Siskiyou rated "very good" in standard food-processing tests that pureed, juiced or individually quick-froze the berries. Fresh blackberries are low in calories, contain only a trace of sodium, and are cholesterol-free. They are high in fiber and vitamin C and are a source of potassium and the B-vitamin folate. The Oregon Raspberry and Blackberry Commission helped fund the research.

Horticultural Crops Research Laboratory, Corvallis, OR

Chad E. Finn, (541) 750-8760, finnc@bcc.orst.edu

Southeastern nurserymen can "swing" to the tune of 'Biloxi,' a new southern highbush blueberry cultivar. Developed by ARS scientists, Biloxi's fruit is medium in size, has good color, flavor and firmness, and has small picking scars. It blooms and ripens a few days earlier than Jubilee, a popular ARS-developed commercial variety. That early ripening boosts Biloxi's market price, though growers should take precautions against late spring freezes. In field plantings, ARS researchers have not observed any virus symptoms on this cultivar. ARS scientists recommend growers plant Biloxi in areas where southern highbush blueberries are successfully grown, mainly in the U.S. Gulf coast region. The new cultivar may contribute to the lucrative \$31 million-a-year southeastern blueberry industry. Nurserymen who want rooted cuttings should contact ARS' Small Fruit Research Station in Poplarville, MS. Plant material will be deposited in the U.S. National Plant Germplasm System for further research development and commercialization of new cultivars.

Small Fruit Research Station, Poplarville, MS

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Two strawberry varieties that bear sweet, juicy, bright-red fruit by the Fourth of July have now been officially named "Firecracker" and "Independence." ARS scientists, in cooperation with Oregon State University and Washington State University, released these top-performing, Pacific Northwest berry plants to growers this year. The plants have undergone more than a decade of tests. Until now, the berries had been known as ORUS 1077-47 and ORUS 1076-126. In tests at commercial fields in Oregon, Firecracker and Independence produced fruit for 5 to 7 days longer than

the Pacific Northwest's current late-season leader. Firecracker produces mostly medium-size berries. Delicious when eaten fresh, Firecracker strawberries were also rated very good for processing in experiments of pureed or individually quick-frozen berries. Independence also did very well in food-processing tests, but its green cap is difficult to tug from the berry's crown. This makes the berry uneconomical for processing. In field tests in Oregon, Washington and British Columbia, Canada, Independence was undaunted by insects, diseases and bad weather. It produced large, firm berries. The Oregon Strawberry Commission and Washington Strawberry Commission provided some of the funding for the studies. Strawberries are low in calories and high in vitamin C. They are a good source of fiber and potassium and provide folate, a B vitamin. *Horticultural Crops Research Laboratory, Corvallis, OR*

Chad E. Finn, (541) 750-8760, finnc@bcc.orst.edu

A newly released grass outproduces other forages now grown in the tropics. The new ARS-developed grass, called *Brachiaria-Panicum* Interspecific Hybrid 104 (BPIH104), yielded 35,720 pounds per acre per year during a 1-year field study. That's considerably more than the 32,148 pounds per year the local common guinea grass produced. The new grass is a hardy year-round plant that can reach a height of 8.5 feet with blades about 1/3 to 4/5 inch wide. BPIH104 could be cut for hay or grazed by beef and dairy cattle. It's suitable for warmer southern U.S. locations such as Florida. Seeds will be stored at the U.S. National Plant Germplasm System. Plant material is available from the ARS Tropical Agricultural Research Station, Box 70, Mayaguez, PR 00681.

Tropical Agricultural Research Station, Mayaguez, PR Antonio Sotomayor-Rios, (787) 831-3435, ext.232, mayas@ars-grin.gov

A newly released ARS hop variety, named Santiam, offers brewers and beer drinkers the prized aromas until now found only in hops from Germany's Tettnang region. Hops supply beer's distinctive aroma and the zesty bitterness that balances the sweetness of the malted barley. The original Tettnanger variety can be grown in the U.S., but it does not yield as well here as in its homeland. Santiam yields twice the hops as Tettnanger when grown in Oregon, Washington and Idaho, the prime U.S. hop-growing areas. Santiam is

also the world's first naturally seedless Tettnang-type hop. Brewers want seedless hops because seeds can add undesired oils to beer. Seeds also add useless weight, complicating pricing negotiations between brewers and growers. With Santiam, ARS has provided domestic alternatives to all three premier European aroma hops: Tettnanger, Hallertau and Saaz. At least one-third of the hops in American brews have ARS origin. U.S. growers produce one-fourth of the world's hops, and many foreign beers also include ARS-released hops.

Forage Seed Production Research Center Corvallis, OR John Henning, (541) 750-8746, jhenning@css.orst.edu

Horizon, a recently released ARS hop variety, has less cohumulone than any commercial hop. High cohumulone levels can cause an off-taste in beer. Another Horizon advantage: Brewers normally use at least two different types of hops—one for hearty aroma, the other for the bittering qualities. Horizon provides both. It contains high levels of alpha acids, which provide bitterness. But unlike many high-alpha-acid hops, Horizon also has good aroma qualities. ARS hop varieties made up 64 percent of all U.S. hop acreage in 1997, worth about \$76 million of the \$117 million industry. Horizon was originally developed two decades ago but was not publicly released because it is susceptible to downy mildew. Still, because it grows well in semi-arid areas of Washington where downy mildew is not a problem, Horizon was released at the request of the industry.

Forage Seed Production Research Center, Corvallis, OR

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Two new sugarbeet breeding lines have resistance to root rot and leaf spot, two of the most devastating diseases of beets worldwide. ARS scientists released the two lines, FC709-2 and FC727, in cooperation with the Sugar Beet Development Foundation in Denver, CO. Each was developed from genetically different sources. In tests from 1994 to 1997, both lines showed excellent resistance to *Rhizoctonia* root rot caused by the fungus *Rhizoctonia solani*. FC709-2 has good resistance to *Cercospora* leaf spot caused by the fungus *Cercospora beticola*. FC727 has some resistance to leaf spot. The scientists say these new lines help fill the need for high-yielding hybrids with host resistance to leaf spot. This disease infects about half of all U.S. sugarbeet acreage, causing millions of dollars worth of losses each year.

Sugarbeets rank seventh among U.S. agricultural row crops, with an annual production value of more than \$1.2 billion. Today, about 31 percent of the world sugar consumed and 47 percent of U.S. sugar consumed is from sugarbeets. Commercial breeders can obtain seed of the two new breeding lines from ARS.

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Computer Systems and Models

A newly updated "Data Logging Temper Tester" should help scientists develop and evaluate improved tactics and chemicals to prevent bee attacks—or lessen their intensity. Newly outfitted with memory and microcontroller chips, the Data Logging Temper Tester is the latest generation of a model originally patented by ARS in 1991. The device logs bees' attempts to sting a black, plastic egg-shaped target about twice the size of a chicken egg. In one experiment, a hive of 40,000 honey bees struck or "pinged" the target more than 700 times in 5 minutes, according to records downloaded from the data logger to a personal computer. By profiling the attack in ten-second intervals, the logger revealed a peak of 80 stings in 10 seconds, or 8 stings per second. Scientists deliberately provoked the colony for this test. Because the target can be suspended at virtually any distance from the hive, the device also reveals how far bees will fly from their home to attack. Of greatest concern are Africanized honey bees in Arizona, California, Nevada, New Mexico and Texas. They sting readily and in great numbers, with little or no provocation.

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ARS scientists in Minnesota are working to make the Snowbelt's early spring weather forecasts more accurate. They've done this by burying heat-measuring plates in the soil below the snow and simultaneously measuring evaporation and heat exchange between the snow surface and the atmosphere. Automated field weather stations add up all of the radiant energy available at the Earth's surface. The scientists then subtract all but one of the ways this energy is used. What they subtract is the energy used to evaporate surface moisture and the energy used to warm air and

soil. What remains is the energy used to melt snow. From this, they can predict snowmelt rates over large areas. Available methods for estimating snowmelt rely primarily on computer models, manual snow sampling and automated snow-weighing "pillows" that are more suited to deep snow regions of the mountainous West. The ARS scientists are working with the National Oceanic and Atmospheric Administration to use the new snowmelt estimates to make the computer models more accurate. These models are needed to predict short- and long-term weather and climate, including spring flooding and global climate change. The data are also needed for agricultural models that predict runoff and amounts of chemicals carried offsite in water.

Soil and Water Management Research Unit, St. Paul, MN

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Beef producers can now tap into up-to-date research via a new computer model that helps farmers and ranchers match their herd's feed and genetic resources to best meet market demands. Called DECI, for Decision Evaluator for the Cattle Industry, the user-friendly model explores "what if" management scenarios to help producers avoid costly mistakes or missed opportunities that otherwise might go unrecognized for years. DECI ties several databases together in a way that lets producers use large amounts of research information without being overburdened by it. The model is designed to evolve with the newest research findings. It could eventually help producers determine profits for producing cattle marketed under a premium pricing system based on qualities such as meat leanness rather than carcass weight.

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Into the Marketplace

Cooperative Research and Development Agreements

...With Ava Chemical Ventures, Portsmouth, NH, to conduct further studies to identify a form of synthetic sugar ester that is highly water soluble yet remains active in killing insect pests. Leaves of a wild relative of tobacco make natural sugar esters that kill whiteflies and other soft-bodied pests. A new synthetic version of the active ingredient in natural esters has commercial potential as a pest killer, ARS scientists say. Sugar esters break down the outer coating of the pest, causing its body to shrivel as it loses water. In field tests, spraying a mix of water and esters extracted from plants killed

Contact the scientists listed for further information on each research project. For general questions about this report, contact Hank Becker, ARS Information, 5601 Sunnyside Avenue, Beltsville, MD 20705-5129, (301) 504-1624, hbecker@asrr.arsusda.gov

Items marked with the word PATENT are being patented by ARS. For more information on patents, CRADAs and patent licenses, contact ARS Office of Technology Transfer, Bldg. 005, Rm. 416, BARC-West, Beltsville, MD 20705, (301) 504-5734. Questions about a company's product and/or research should be directed to the company itself.

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all the pear psylla—a soft-bodied insect pest—infesting pear leaves. The spray even killed pear psylla that hatched 3 days later. Sugar esters are relatively nontoxic to beneficial, hard-bodied predators such as lady beetles. But extracting the compounds from plants is difficult and expensive. Synthetic esters would sidestep these drawbacks. ARS scientists working with Ava Chemical Ventures found an easier, cheaper way to mass-produce sugar esters. The new synthetic compound can easily be mixed and sprayed using standard tank sprayers. In field and lab tests, the new compound controlled pear psylla, whiteflies, aphids, thrips and other pests without harming beneficials. ARS scientists believe the new ester may be registered as early as 1999. Ava has applied to register the ester's use with the U.S. Environmental Protection Agency and the California Department of Agriculture.

*Appalachian Fruit Research Station, Kearneysville, WV
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...With the Canadian Pacific Railway, Minneapolis, MN, to use alfalfa plants to clean up the site of a 1989 railcar spill of nitrogen fertilizer. An ARS study under way since 1996 shows that a special type of alfalfa is helping to clean the affected area. The alfalfa is called Ineffective Agate because, unlike regular varieties, it forms ineffective root nodules that are unable to use nitrogen from the air. So, it must get all its nitrogen from water and soil. This trait would normally be considered a flaw for a legume crop—but it's what makes Ineffective Agate highly effective for environmental clean-up. Before the spill near Bordulac, ND, ARS scientists had conducted tests and found that Ineffective Agate would take up 30 to 40 percent more nitrogen from soil and water than would standard alfalfas. Previous cleanup efforts at the site included excavating topsoil and irrigating nearby corn and wheat with pumped groundwater. But the groundwater and soil still had excessive levels of nitrogen. Since 1996, Ineffective Agate has taken up about 250 pounds of nitrogen per acre per year, compared with 70 pounds

for corn or wheat crops. The ARS scientists are collaborating with North Dakota State University Carrington Research and Extension Center and Braun Intertec Corp., an environmental consulting firm. In 1997, a cooperating farmer harvested the alfalfa for hay three times. About 300,000 gallons of groundwater were pumped and used to irrigate the alfalfa. With the early spring warmth and more normal summer rainfall, researchers hope to pump a million gallons this year and to harvest the alfalfa four times. They predict this will boost the nitrogen removal rate to nearly 450 pounds per acre and remove the excess nitrogen from the groundwater and soil.

Plant Science Research, St. Paul, MN

Michael P. Russelle, (612) 625-8145, russelle@soils.umn.edu

...With Finnfeeds International, Helsinki, Finland, to see if feeding fish an all-plant-protein diet with a key liquid enzyme will help them grow more efficiently. The research should help fish farmers reduce feed and production costs, improve the nutritional value of fish diets and increase farmer profits. The enzyme is a protease, which can help the fish more readily digest and absorb the plant (soy-based) food. ARS scientists want to see whether the plant protein feed supplemented with protease can replace the standard, more expensive feed containing fish meal. The fish under study are tilapia, popular in Asian countries—and showing up on more U.S. menus. Since 1997, U.S. fresh and frozen tilapia imports have increased 28 percent. The expanding market has led more American fish farmers to raise this tropical beauty. ARS scientists also want to know if the protease supplement can improve nutritional value of soybean-based meals for other aquiculture species.

Fish Diseases and Parasites Research Lab, Auburn, AL

Chhorn E. Lim, (334) 887-4525, limchh@mindspring.com

...With Small Potatoes, Inc., Madison, WI, to test an ARS-developed gene for lowering levels of natural chemicals called glycoalkaloids in otherwise promising strains of experimental potatoes. The experimental potatoes may boast valuable traits such as appealing color, texture, or resistance to insects or disease. But these spuds have zero commercial potential if they also contain high levels of bitter-tasting glycoalkaloids. ARS and Small Potatoes, Inc., scientists will test a gene constructed

by an ARS team in California. Potatoes possessing the rebuilt gene had up to 50 percent less glycoalkaloids in preliminary experiments. The new gene may open the door to superb new potatoes for baking or processing into chips, fries and other tasty potato products. Potatoes are America's favorite vegetable. The 1996 U.S. crop of 25 million tons was worth \$2.4 billion to growers.

Western Regional Research Center, Albany, CA

William R. Belknap, (510) 559-6072, wrb@pw.usda.gov

...With Perry Trittech, Inc., Jupiter, FL, to develop technology to improve the design and operation of plows that bury undersea cables.

This kind of plow has a knife-like blade connected by a cable to a ship, which pulls the plow along the sea floor. The blade slices a narrow furrow into the ocean bed so that fiber-optic communications cable can be buried. This protects the cable from damage by fishing nets, boat anchors and natural forces. ARS scientists working with the company have unique facilities for conducting tillage and traction research. And undersea plow blades are similar in design and operation to tillage blades used on farmland. The tests should help improve blade design—a benefit to both the agriculture and communications fields—and conserve energy. The undersea communications business is a multibillion dollar industry.

National Soil Dynamics Laboratory, Auburn, AL

Donald C. Erbach, (334) 844-4517, derbach@eng.auburn.edu

Licenses

...To DEKALB Genetics Corp., DeKalb, IL, to use an ARS-developed corn that should boost the grain's nutritional value and reduce phosphorus pollution. The experimental corn contains up to 66 percent less phytic acid, a phosphorus-containing compound. Because animals with one stomach, such as pigs and poultry, cannot use phytic acid, much of the phosphorus in conventional corn ends up in their manure. When carried by rainwater to nearby lakes and streams, the phosphorus may turn into a pollutant, nourishing algae that use up oxygen needed to keep fish and other aquatic dwellers alive. Some of the low-phytic-acid corn produced in ARS experiments contained two-thirds less phytic acid, with no reduction in phosphorus content. And, some test animals fed the experimental corn excreted 25 to

40 percent less phosphorus in their manure. DEKALB researchers will experiment with breeding the low-phytic-acid trait into some of the company's proprietary hybrids. The new corn may prove less expensive to farmers than giving their animals phosphorus supplements or treating conventional feed corn with natural enzymes that break down phytic acid. (PATENT 5,689,054)

Small Grains and Potato Germplasm Research Unit, Aberdeen, ID

Victor Raboy, (208) 397-4162, vraboy@uidaho.edu

...To Betterbee, Inc., Greenwich, NY, to produce a new ARS-developed product that could give U.S. beekeepers a superior, alternative protection against varroa mites. These pests are becoming resistant to the standard control, fluvalinate, sold as Apistan. In tests, the new treatment—a gel containing formic acid—killed up to 84 percent of varroa mites and 100 percent of tracheal mites, another bee pest. The gel protects keepers and hives from toxic formic acid fumes. It is sealed in a small plastic bag that beekeepers would simply slice open and place in the hive. The acid slowly evaporates, killing the mites without contaminating the hive or honey. The company expects to have a product ready for EPA review soon.

Bee Research Laboratory, Beltsville, MD

Hachiro Shimanuki (301) 504-8975,

hshimanu@asrr.arsusda.gov

Patents

Strong doughs from wheat flours make large loaves of light, fine-textured bread. By rebuilding some wheat-flour genes, ARS genetic engineers have increased a key indicator of dough strength: the time it takes to mix the dough. To accomplish this, the scientists retooled some of the genes, known as high-molecular-weight glutenin genes, by making longer versions of the naturally occurring ones. The central sections of these new genes have more "repeats" of a portion of genetic material thought to be key to dough strength and the dough's ability to trap and contain tiny bubbles of carbon dioxide gas. Formed naturally by yeast during mixing, the bubbles enable doughs to rise, forming high, delectable loaves. (PATENT APPLICATION 08/785,716)

Western Regional Research Center, Albany, CA

Olin D. Anderson, (510) 559-5773, oandersn@pw.usda.gov

A pheromone identified by ARS scientists may one day give fruit growers an early warning of plum curculio weevils. By revealing the pests' first arrival in an orchard, a trap containing the pheromone could give growers precious time for a pre-emptive strike that protects the fruit and prevents the weevils from reproducing. The weevils, *Conotrachelus nenuphar*, attack apples, peaches, cherries and plums in the southern and western U.S. Adult female weevils lay eggs under the skin of embryonic fruits, causing yield loss and scarring. Normally, a grower becomes aware of the pests only after the eggs are laid, when a telltale "crescent moon" blemish appears on the embryonic fruit. Once this "moon" has risen, the fruit will wind up scarred. But ARS scientists identified a natural chemical pheromone, grandiosic acid, that the male curculio moth releases to attract females. In outdoor tests, scientists hung traps baited with the attractant in orchards at blossom time. This snared female curculio moths before they could begin laying eggs. The growers had enough time to apply insecticide before the trees dropped their petals. It's too late to spray for plum curculio once the petals drop and the fruit begins forming. ARS scientists patented the pheromone trap and are seeking companies to license the technology. (PATENT 5,714,139)

Food Safety and Quality Research, Peoria, IL

Fred J. Eller, (309) 681-6232, ellerfj@mail.ncaur.usda.gov

The free lunch may be over for hungry rice weevils, sawtoothed grain beetles and other stored grain pests, thanks to the ARS-patented Electronic Grain Probe Insect Counter (EGPIC). EGPIC is the latest improvement in technology that monitors insects in stored grain. It includes an infrared beam to sense insects. And it quickly, accurately and economically records and time-stamps when the pest drops through a probe trap. Current probes remain in grain bins until an inspector manually removes and visually inspects them. EGPIC sensors transmit insect counts back to a central computer via SMARTS (PATENT APPLICATION 08/556,054), a data transmission network for large-scale monitoring by up to a million probes. Insect infestations cause millions of dollars in stored-product losses and fumigation costs each

year. EGPIC will allow companies to target heavily concentrated insect areas of a grain bin with fumigants or other control alternatives, eliminating the need to treat the entire bin. (PATENT 5,646,404)
Center for Medical, Agricultural and Veterinary Entomology, Gainesville, FL
Dennis Shuman, (352) 374-5737,
dshuman@gainesville.usda.ufl.edu

Genetic Resources

Sunflower can be genetically revamped to produce frying oil that would allow snack food processors to label potato chips fried in it as "low in saturated fat." Foods with that label must have less than one gram of saturated fat per 1-ounce (28.4 grams) serving. ARS scientists have developed eight new mutant sunflower genetic stocks with seeds low in either palmitic or stearic acids. By combining genes from two of these stocks, breeders can develop lines that produce oil with nearly 30 percent less saturated fatty acid than traditional hybrids. To reduce saturated fat even further, the researchers have crossed these lines with a new class of sunflower hybrid called NuSun. Vegetable oil from NuSun has several times more oleic acid than traditional sunflower oil and less than half as much linoleic acid, a composition that helps the oil hold up well in frying vats even without undergoing a process called hydrogenation.

Red River Valley Agricultural Research Center, Fargo, ND
Jerry F. Miller, (701) 239-131, millerjf@fargo.ars.usda.gov

Coda, a new ARS club wheat variety, resists strawbreaker footrot, one of the most devastating fungal diseases in the Pacific Northwest. Washington, Idaho and Oregon produce most of the nation's club wheat, and exports supply virtually all Asia's club needs. Japan and other Pacific Rim countries prize a special mixture of club and soft white wheat called Western White for making sponge cakes and other confections. Club wheat is a type of soft white wheat that has unique flour qualities and more compact grain heads than typical soft white wheat. Coda is the first club wheat that has both the disease resistance and quality bakers and consumers demand. Coda can replace Hyak, a club wheat with footrot resistance—and an unwanted gene that reduces flour quality. Coda does

not have this gene and also yields more than Hyak. The ARS variety Madsen, which also carries this disease resistance, has saved growers millions of dollars annually in reduced pesticide use.
Wheat Genetics, Quality, Physiology and Disease Research, Pullman, WA
Robert E. Allan, (509) 335-3632, allanre@mail.wsu.edu

"RoadCrest," a hardy new crested wheatgrass from ARS and Utah State University researchers, may be helping control erosion along roadsides and highways in the West within a few years. This grass "greens up" earlier in spring than many others that scientists scrutinized in tests in Utah, Colorado, Wyoming and Washington. Also, RoadCrest requires less seed to establish a healthy stand, and is shorter in stature, a trait that helps reduce the need for costly mowing. It tolerates cold and drought, and readily forms rhizomes—horizontal, underground stems that send up new shoots to create attractively uniform, gap-free growth. RoadCrest is a descendant of parent plants collected as seed in Turkey and sent to ARS for grass-breeding experiments. A perennial, cool-season grass, RoadCrest should thrive in temperate, semi-arid areas of Intermountain and Great Plains states. In those regions, it is best suited for sites that have mild summer temperatures and receive about 10 to 20 inches of precipitation a year. The state of Utah helped fund the research. Seed should be on sale by the year 2000.

Forage and Range Research, Logan, UT
Kay H. Asay, (435) 797-3069, khasay@cc.usu.edu

Most gardeners know how to trick bulbs into blooming indoors out of season with refrigeration. But the Chesapeake series of ornithogalums from ARS research will give flower lovers holiday blossoms without cold treatments. These "flowers of fire" disguise themselves as houseplants most of the time but explode with colorful blossoms several times during the year. ARS scientists, working with a California breeder, created this new take on the classic Star-of-Bethlehem lily. Unlike the traditional white-flowered members of *Ornithogalum*, 'Chesapeake Blaze,' 'Chesapeake Sunburst' and 'Chesapeake Sunset' add a special orange-red and golden fire to this floral family. Bulbs are available from Bay City Flower Company in Half Moon Bay, CA.
Floral and Nursery Plants Research, U.S. National Arboretum, Beltsville, MD
Robert J. Griesbach, (301) 504-6574,
griesbac@asrr.arsusda.gov

Human Nutrition

Wheat bran heated and shaped into short, crispy strips for a commercial breakfast cereal was more effective than raw wheat bran in reducing an indicator of colon cancer in laboratory rats, a new study shows. ARS and University of California at Davis School of Medicine researchers conducted the 6-month test. Bran is the thin, fiber-rich outer layer of the wheat kernel. Scientists have known for more than a decade that feeding raw wheat bran to lab animals reduces the occurrence of aberrant crypt foci, or ACF, thought to be a colon cancer precursor in rats and humans. The California experiment, however, is apparently the first to show that processing the bran with a machine known as an extruder may boost bran's effectiveness in reducing ACF. Of the 120 white lab rats in the study, those fed a diet that included processed wheat bran had 33 percent fewer aberrant crypt foci in their colons than those fed raw wheat bran. The animals had been injected with a chemical that stimulates formation of ACF. Colorectal cancer is the second deadliest cancer in the U.S., killing nearly 55,000 Americans every year. Kellogg Co., Battle Creek, MI, funded part of the experiment under a cooperative research and development agreement with ARS.

Western Regional Research Center, Albany, CA

Wallace H. Yokoyama, (510) 559-5695, wally@pw.usda.gov

Women and girls battling severe eating disorders may suffer bone mineral loss. New evidence from ARS-funded research suggests that use of estrogen and progestin hormones may guard against this loss of calcium. The natural menstrual cycle circulates hormones that play a role in maintaining strong bones. But the risk of osteoporosis later in life increases if normal menstruation is interrupted because of an eating disorder. Scientists found that women suffering from these disorders maintain their spines and skeletons better with hormone therapy. They suspect that the treatment, by mimicking the hormonal activity of a normal menstrual cycle, could stem mineral loss until other medical care can restore the patients' general health—and natural menstrual cycle. The research was published in the *American Journal of Obstetrics and Gynecology*.
Children's Nutrition Research Center, Houston, TX
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Two cardiovascular health indicators improved in six volunteers who ate foods enriched with a natural compound called DHA. The volunteers showed an increase in HDL-cholesterol—the kind known to protect against heart disease. And their blood fats, called triglycerides, decreased by about 26 percent. DHA, short for docosahexaenoic acid, occurs in fish and meats and belongs to the omega-3 family of fatty acids. Volunteers on the high-DHA regimen also showed an increase of about 69 percent in apoprotein-E, a compound that carries cholesterol to the liver for breakdown and excretion. An apo-E increase had not yet been noted in other DHA studies with humans. Ten healthy, non-smoking men age 20 to 39 lived at the ARS Western Human Nutrition Research Center in San Francisco for the four-month investigation, making it the longest DHA experiment yet reported with in-residence volunteers. For three months, about a teaspoon of DHA-rich oil was added to salad dressings or bean, salsa or guacamole dips served to six volunteers, substituting safflower oil in the servings for the four other men. Scientists designed the study to distinguish the effects of DHA from those of another omega-3 fatty acid, EPA. Both occur in fish oils thought to have cardiovascular benefits.

*Western Human Nutrition Research Center,
San Francisco, CA*

Gary J. Nelson, (415) 556-0899, gnelson@whnrc.usda.gov

New findings suggest African-American women living in the northern latitudes may benefit from increasing their vitamin D intake. The vitamin is essential for absorbing calcium and thus integral to strong bones. Compared to Caucasian women, the African-American women in an ARS study had about half as much 25-hydroxyvitamin D—the most sensitive measure of D status—circulating in their blood throughout the year. The African-Americans also had smaller increases in circulating vitamin D during summer. Sunlight stimulates skin to make the vitamin, but pigmented skin makes less. What's more, in the winter when vitamin D levels are lowest, an important hormone called parathyroid hormone was elevated only in the African-American women. This hormone signals low blood calcium and can stimulate loss of calcium from the bones. Apparently, African-American women living in northern latitudes don't manufacture enough vitamin D during the summer to carry them through the winter months, the researchers concluded. The

amounts of vitamin D and calcium in the diets of the two groups of women did not differ enough to explain the differences in their blood levels of the vitamin.

*Jean Mayer USDA Human Nutrition Research Center on Aging at Tufts, Boston, MA
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Food Safety and Quality

A simple switch in cattle diets—from corn to hay—for the last five days before slaughter could reduce the risk of *E. coli* infection in humans, new research suggests. *E. coli* causes about 20,000 infections of people and 200 deaths a year in the United States. ARS and Cornell University scientists conducted preliminary studies with 61 head of beef cattle. The scientists found that cattle fed corn grain tended to develop heartier, acid-resistant strains of *E. coli* in their digestive tracts. Acid resistance facilitates the passage of bacteria through the gastric stomach and allows them to colonize the human colon. Switching to hay just before slaughter reduced the occurrence of these strains. Most *E. coli* strains occur naturally in cattle, are harmless and do not harm people. But some strains are very dangerous, especially *E. coli* 0157:H7. It can cause bloody diarrhea, kidney failure and death in humans. Meat can be contaminated with the bacteria if it comes in contact with feces at slaughter. The new research reveals a previously unknown mechanism that enables the bacteria to develop acid resistance. Some undigested grain ferments in the animal's colon, producing volatile fatty acids. *E. coli* bacteria, including the 0157:H7 strain, develop genetic defenses that help them thrive in this low-pH environment. But cattle digest hay easily; as a result, acid levels in the colon remain low, discouraging the development of acid-resistant bacteria. More comprehensive evaluations using larger numbers of animals are planned. The team also plans to test other grains in addition to corn.

*U.S. Plant, Soil and Nutrition Research, Ithaca, NY
James B. Russell, (607) 255-4508, jbr8@correll.edu*

Campbell's Soup and Beech-Nut are using an ARS-developed technique to screen fruits and vegetables for pesticides before buying them. The companies take samples of the produce to their laboratories where they use an automated technique

that can spot any of more than 50 major pesticides in several classes, such as the insecticides chlorpyrifos and permethrin, an organophosphate and pyrethroid, respectively. The method was developed by an ARS chemist for commercial use and use by regulatory labs. The North Carolina Department of Food and Agriculture has adopted the technique, which is an automated use of supercritical fluid extraction, a method used to safely decaffeinate coffee, for example. It eliminates almost all use of liquid solvents for the analysis. The technique saves time and money as well as being more accurate than standard techniques: 85 to 100 percent, depending on the pesticide. And it can detect some pesticides that are missed by standard techniques. The method was developed on grapes, carrots, potatoes and broccoli. The fruits and vegetables are shredded and mixed in a food processor to prepare samples. Analysis of the samples compared favorably with results from seven laboratories using traditional detectors and solvent-based extraction procedures. *Environmental Chemistry Laboratory, Beltsville, MD
Steven J. Lehotay, (301) 504-6511,
slehotay@arsrr.arsusda.gov*

A new simple, inexpensive test accurately detects *E. coli* 0157 in food products. An ARS scientist developed the test from equipment and technology patented by IGEN International, Inc., of Gaithersburg, MD. Antibodies—molecules custom-tailored to bind to a specific substance—are key to the test, which uses magnetic beads coated with an *E. coli* 0157 antibody and a ruthenium-labeled antibody. Ruthenium is a metal that, through an electrochemical reaction, emits light that helps detect *E. coli*. The new test works on hamburger meat and is 10 to 100 times more sensitive than other *E. coli* tests. No special training is necessary. The equipment, including a computer, fits on a small table. About 50 samples per hour can be tested. They're loaded onto a tray similar to the carousel of a slide projector. Total time from sample to answer: only 6 to 8 hours. Several large commercial meat suppliers are evaluating the test. From the new assay, IGEN hopes to develop a line of fast, highly sensitive tests that will help food producers detect contaminants.

*Eastern Regional Research Center, Wyndmoor, PA
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cgcrawford@arserrc.gov*

Routine pasteurization safeguards milk from an organism known to cause a cattle disease—and suspected by British researchers to be linked with Crohn's disease in people. High-temperature, short-time pasteurization (HTST) is routinely performed on commercial Grade A milk. ARS researchers determined that HTST kills *Mycobacterium paratuberculosis*, the organism that causes Johne's disease in cattle. *M. paratuberculosis* is shed in low quantities in the milk of some Johne's-infected cows, so ARS researchers conducted the pasteurization studies—simulating industry conditions—after a 1994 British scientific report. The British researchers suggested that the Johne's organism might cause Crohn's disease, a severe intestinal disease in humans. In the laboratory, ARS researchers inoculated raw, unpasteurized milk with two strains of the bacterium: one from an infected cow and the other from a Crohn's patient. The milk was held at 162° F for 15 seconds. When milk samples were re-checked 6 months later, scientists again found no evidence of *M. paratuberculosis*. Despite this organism's name, it has no connection to tuberculosis in either cattle or humans.

National Animal Disease Center, Ames, IA

Judith R. Stabel, (515) 239-8325, jstabel@nadc.ars.usda.gov

Now, cut-up honeydew melons stay fresh and marketable 2 days longer—a 20 percent improvement—thanks to new procedures for controlled atmosphere (CA) storage worked out by ARS scientists. Treated melon sections also have less microbial growth than the control samples. Honeydew cubes prepared at the supermarket typically have a sale date of only 2 or 3 days after they're cut. An ARS food technologist subjected cut-up honeydews to a CA of 2 percent oxygen and 10 percent carbon dioxide at 41°F for 9 days. The control sample was stored in air. On day 5, melon cubes in CA had less bacterial growth and stronger honeydew aroma than the controls. On day 6, CA-stored samples were still moist, with good green color, aroma, taste and sweetness that lasted through day 9. Control samples had microbial growth and an offensive odor by day 9. This research also showed that with controlled atmosphere storage, maintaining the packaged, cut-up honeydews at 41°F at all times is crucial.

Horticultural Crops Quality Laboratory, Beltsville, MD

Alley E. Watada, (301) 504-5107, awatada@asrr.arsusda.gov

A new way to chemically change vegetable oils produces solid margarines with lower levels of trans fatty acids than the conventional method of hydrogenation. That's good health news for consumers, because studies have shown that trans fatty acids can raise cholesterol levels in some people. Hydrogenation involves heating a fat mixture under high heat and pressure to chemically add hydrogen. But that results in high levels of trans fatty acids—between 10 and 30 percent. In the new process called low-trans hydrogenation, scientists changed some parameters of hydrogenation. The result was oil with a chemical structure that allows scientists to make margarine with less than 8 percent trans fatty acids. ARS scientists are working to further develop that technology for commercial food applications. *Food Quality and Safety Research Laboratory, Peoria, IL*
Gary R. List, (309) 681-6388, listgr@mail.ncaur.usda.gov

Two wheat genes now being scrutinized by ARS researchers in California might increase the use of starch made from wheat flour. The genes direct wheat to make enzymes that, in turn, are used to make molecules called amylopectins. With the genes, researchers might soon be able to increase the amount of amylopectin molecules and decrease the quantity of another kind of starch molecule known as amylose. That may result in value-added, low-amylose flour—the kind used for noodle-making because it improves texture. Reduced-amylose flour may also improve doughs for frozen foods like pizza crusts or ready-to-bake breads by helping maintain flavors. Other researchers had already found similar starch genes in corn, but the ARS team was among the first to find counterpart genes in wheat.

Western Regional Research Center, Albany, CA

Kent F. McCue, (510) 559-5796, kmccue@pw.usda.gov

IPM/Biological Control

A natural protein from the giant silk moth holds promise as a new way to protect cotton crops from noxious fungi like *Aspergillus flavus*. The fungus produces a natural carcinogen called aflatoxin that can make cottonseed unfit for animal or human consumption. Proteins called peptides derived from moths or other natural sources are of scientific interest as built-in antifungal agents for genetically altered cotton plants. Preliminary studies show that L-cecropin B, the moth peptide, can kill

100 percent of *A. flavus* fungi—but only when the fungi don't secrete a potent enzyme that can degrade the peptide. To overcome the problem, scientists rebuilt the moth's peptide, essentially by repositioning certain amino acids that otherwise would succumb to fungal degradation. Later, they exposed laboratory cultures of *A. flavus* to the rebuilt peptide, D-cecropin B. It not only resisted degradation, but also killed the fungus at concentrations of 5 to 98 parts per million. The peptide has caught the eye of scientists at the National Institutes of Health. They've begun preliminary studies to explore its therapeutic potential to treat fungal infection in humans with weakened immune systems. The peptide may also prove useful in veterinary medicine.

*Southern Regional Research Center, New Orleans, LA
Anthony DeLucca, (504) 286-4253,
adelucca@nola.srrc.usda.gov*

A bacterium without cell walls is behind the poinsettia plant's beauty and popularity as a Christmas favorite, ARS and industry scientists say. Their studies show that the wall-less bacterium, called a phytoplasma, serves as a dwarfing agent that keeps the poinsettia from reaching eight or more feet—the norm in its native Mexico. In the U.S., consumers prefer a short, full-bodied plant about 16 to 18 inches high that can rest atop a table or window sill. The phytoplasma triggers a hormonal imbalance that instructs the plant to form more auxiliary branches. So, it grows outward rather than up. This phenomenon, called free-branching, also produces more of the brilliant red leaf-like structures called bracts. Until recently, scientists suspected the poinsettia mosaic virus as a causative agent. That's because treatments to eliminate it also stop the free-branching trait in the plant. For florists, it's been a love-hate relationship because the pathogen sometimes causes disease that distorts the shape and color of the plant's leaves. Scientists with ARS and Ball FloraPlant of West Chicago, IL, exposed poinsettia mosaic virus for what it truly is: a costly nuisance that plays no part in free-branching. They employed a nonhost plant called periwinkle and a parasitic vine called dodder as a bridge or graft that infects poinsettias with the phytoplasma but not the virus. This led to the first, free-branching poinsettia plants that have phytoplasma, but no mosaic virus.

*Molecular Plant Pathology Laboratory, Beltsville, MD
Ing-Ming Lee, (301) 504-6024, imlee@asrr.arsusda.gov*

New biochemical tests can demonstrate for the first time the effectiveness of spiders and other predators in controlling several insect pests. ARS researchers have been developing and perfecting tests that use serological analysis—antibodies or custom-designed molecules—in assays to identify the remains of prey in a predator's gut. They say these tests are the most efficient and direct approach to gathering long-term data on spider predation. One test distinguishes cotton bollworms from the tobacco budworm and ground cherry fruitworm. Last year in a Georgia cotton field, the scientists determined that about one-fourth of the specimens of a single spider species had dined on eggs of two cotton pests. In Colorado, they conducted the first North American survey for spiders that kill cereal aphids and other wheat pests. Now, they're developing monoclonal antibodies against three major cereal aphids—the greenbug, Russian wheat aphid and corn leaf aphid. They're collaborating in work on developing monoclonals against the English grain aphid, bird cherry oat aphid and rose grass aphid. With these six antibodies, the scientist will be able to study the role of predators suppressing cereal aphids in many parts of the world. It's part of their ongoing search for more environmentally friendly, economical and efficient biocontrols for insect pests.

ARS Plant Sciences and Water Conservation Research Laboratory, Stillwater, OK Matthew H. Greenstone, (405) 624-4119, mattg@ag.gov

Plants customize their chemical "distress calls" for help from beneficial wasps, ARS scientists discovered. Scientists have known that some plants emit a chemical SOS to recruit tiny parasitic wasps to rescue them from attacking caterpillars. But such wasps tend to be "host-specific," meaning they are choosy about which insect species they'll sting. Now, studies by ARS and university scientists show that some corn, cotton and tobacco plants emit blends of 10 to 12 different volatile compounds, depending on which caterpillar attacks them. The finding refutes an earlier belief that plants release a general, all-purpose SOS to attract wasps. It could also lead to improving the usefulness of wasps for helping control tobacco budworms and corn earworms. The two pests cost farmers more than a billion dollars annually in losses and chemical controls. In crop fields, plants can emit large chemical plumes to alert wasps to a caterpillar attack. But if the caterpillar isn't a preferred host, the wasp may

ignore the signal, subjecting the plant to further damage. To avoid this, plants advertise their attacker's identity with precise mixtures of SOS chemicals. In field experiments, *Cardiochiles nigriceps* wasps flew more often to plants signaling attack by tobacco budworms, a preferred *C. nigriceps* host, than to plants infested by corn earworms, a related species. The wasps visited host-signaling plants 164 out of 198 times. Gas chromatography revealed consistent differences between volatiles emanating from these plants and those from plants signaling an earworm attack.

Insect Biology and Population Management Research Laboratory, Tifton, GA

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Beneficial microbes might help tomorrow's honey bees battle the fungus that causes chalkbrood disease. In beehives, the chalkbrood-causing fungus *Ascosphaera apis* attacks and mummifies bee young—called “brood”—when they are still in the larval stage of their development. In healthy hives, the white, worm-like larvae that hatch from eggs laid by the queen bee develop into cocoon-forming pupae. Young bees later emerge from those pupal cocoons. Larvae attacked by the *A. apis* fungus, however, may turn into tiny mummies that resemble miniature sticks of white, black or mottled-grey chalk. An ARS microbiologist scrutinized microbes living in hives, stored food and bodies of healthy honey bees in the U.S. and abroad. She isolated and identified certain bacteria, yeasts and molds; they apparently produce compounds that inhibit growth of the chalkbrood-causing fungus. With further study, the most promising of the microbes might become the basis for a commercial product to combat chalkbrood. Chalkbrood causes losses costly to beekeepers, growers and consumers. There is no chemical approved for use in this country for controlling the fungus.

Carl Hayden Bee Research Laboratory, Tucson, AZ
Martha A. Gilliam, (520) 670-6380, ext. 121

The small hive beetle, a honeybee pest, was found in the United States for the first time this year. ARS scientists confirmed the identity of the beetle as *Aethina tumida* Murray, known to inhabit only South Africa. There, healthy hives easily resist the beetle, which is considered a native species. An alert beekeeper detected the first infested hives in St. Lucie County, FL. The fear is that many U.S.

hives already weakened by mites or disease may succumb to the beetles. They don't directly attack the bees; instead, they eat and contaminate their honey, ultimately causing bees to flee the hive. Adult beetles lay eggs in empty hive cells near stored pollen and honey. ARS researchers are advising beekeepers to delay placing extra combs on hives until their bees are actually ready to use them. This practice will help deny the beetles getting “squatter's rights” in unoccupied cells.

Bee Research Laboratory, Beltsville, MD

Jeff Pettis, (301) 504-7299, jpettis@asrr.arsusda.gov

Volatile compounds produced by plants in the Brassica or mustard family suppress growth of soil fungi that cause silver scurf and *Verticillium* wilt in potatoes. ARS and Cornell University scientists have identified numerous mustards from around the world that produce prodigious amounts of allyl glucosinolate, also called sinigrin. Using these mustards as breeding stock, the researchers hope to produce improved lines that might be grown as a green manure crop in rotation with potatoes. In laboratory studies, allyl isothiocyanate (AITC)—produced as sinigrin breaks down—was particularly toxic to two pathogenic fungi, *Helminthosporium solani* and *Verticillium dahliae*. AITC also occurs in cabbage and is primarily responsible for the odor of horseradish. In field studies, the scientists are investigating whether plowed-under black and Indian mustards increase soil fertility while suppressing weeds and soil pathogens. As a rotational green manure crop, mustards might also decrease dependence on synthetic chemical pesticides that could contaminate soil and groundwater.

National Center for Agricultural Utilization Research, Peoria, IL

Steven F. Vaughn,

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A new biopesticide spray containing some of the armyworm's favorite ingredients could doom this caterpillar pest and curb its costly mischief in corn, cotton and other crops. ARS scientists are testing the biopesticide in greenhouse and field studies as an alternative to chemical insecticides. Their biopesticide contains a mixture of cottonseed oil, sucrose, water and other ingredients that stimulate armyworm feeding. When sprayed onto plant leaves, this coaxes armyworms to ingest more of the spray's other “active” ingredient: a natural insect pathogen called the *Anagrapha falcifera* nuclear

polyhedrosis virus. The virus kills the insect by reproducing inside its gut cells. But the virus poses no danger to humans, wildlife or beneficial insects like bees. In greenhouse experiments, only 22 percent of 378 armyworms survived after chewing collard plants sprayed with the biopesticide. The scientists are also testing sprays containing stilbene brighteners, compounds that help shield the virus from the sun's ultraviolet light. The most effective biopesticide spray may contain a combination of all three ingredients—virus, feeding stimulant and UV “sunscreen.”

Insect Biocontrol Laboratory, Beltsville, MD
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Two new devices from ARS might boost growers' use of helpful insects and mites and may reduce reliance on chemical pesticides to control crop pests. ARS is seeking a patent for the Aerodynamic Transport Body, or Bugslinger, an innovative modification of skeet or trap shooting targets. Beneficial organisms such as the *Aphelinus nr. paramali* wasp—which attacks cotton aphids—travel in a lightweight, biodegradable disk, launched from the edge of the field. When the disk lands, wasps fly or crawl out of a small exit. The second apparatus, the Mite Meter, also helps speed and simplify the chore of placing beneficials throughout fields. The Meter features a small tank, insulated to keep an inner bottle chilled. The bottle can be filled with western occidental mites, for instance, to attack Pacific spider mites, strawberry mites, two-spotted mites or other plant pests. Inside the inner bottle, beneficial mites rest among corn grits or other “carrier” compounds. A tiny gate dispenses precise amounts of the mite-and-carrier mix onto the ground. Chilling the mites keeps them subdued, ensuring they won't move away from the gate and will be applied uniformly. (Patent Application No. 08/933,124)

Western Integrated Cropping Systems Research, Shafter, CA
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Crop Diseases and Pests

Light and scanning electron microscopy (SEM) can distinguish Karnal bunt fungus in wheat from a lookalike fungus that attacks ryegrass—important news for the \$5-billion-a-year U.S. wheat export market. Sometimes, tiny amounts of fungus-infected ryegrass seed get harvested along with wheat. Until now, available tests have incorrectly

identified the ryegrass fungus as Karnal bunt. As a result, restrictions were placed on the movement of suspect wheat in 1996 and early 1997 from Alabama, Georgia, Florida and Tennessee. ARS scientists analyzed and characterized the teliospores (fungal seeds) of dried and fresh specimens of both the ryegrass and wheat fungus. After examining the teliospores' shape, size, surface characteristics and color, the researchers determined that light and SEM can be used to tell the two fungi apart. Mature teliospores of the wheat fungus (*T. indica*) appear dark red-brown, often opaque, with fine spines that densely cover the outer seed coat. The teliospores of the ryegrass fungus range in color from pale yellow or golden to dark brown, with thicker, more widely spaced spines covering the outer coat. The ARS technique showed that each of the 70 wheat samples collected from southeastern farms in 1996 was contaminated with the lookalike fungus—not Karnal bunt. As a result, in March 1997, the restrictions on movement of wheat were lifted from the counties where the suspect samples originated. Federal plant quarantine officials now use the technique as a “first cut” to decide if possible quarantine actions are needed. If the test results indicate a sample is Karnal bunt, officials go back and look for bunted wheat seeds.

Systematic Botany and Mycology Laboratory, Beltsville, MD
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A grapevine's resistance to attack by a notorious pest known as phylloxera can now be estimated more quickly and easily. Researchers at the University of California at Davis in collaboration with ARS colleagues developed the lab test. It rates a vine's vulnerability to the root louse in only 8 weeks. That will speed the work of breeders and researchers seeking phylloxera-resistant grapevines for California vineyards devastated by the pest. For the assay, scientists sterilize phylloxera eggs and candidate grapevine plantlets to kill any fungi or bacteria that might otherwise skew the resistance ratings. Then, the scientists place eggs and plantlets—rooted in a nutrient-rich gel—inside small, clear-plastic boxes. Insect and plantlet grow in tandem inside these boxes, kept in a temperature-controlled, walk-in chamber. Key to the procedure: Scientists determined how to sterilize the egg surfaces without killing the louse embryo. This makes the technique an improvement over earlier approaches that relied on eggs that were not surface

sterilized. The test has yielded phylloxera-resistance ratings for more than 40 different grape species, most grown from samples from an ARS grape genebank at Davis, CA.

Horticultural Crops Research Laboratory, Fresno, CA
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Scientists are creating a genetic map of the Hessian fly, *Mayetiola destructor*, to help wheat breeders develop varieties with more resistance to this costly crop pest. An early dividend may be the discovery of the location of a gene for the fly's eye color. ARS scientists noted that the white-eye color gene is near the one for virulence against H13, a fly-resistance gene carried by wheat. The close position of these two genes in the fly suggests the white-eye trait can be used to advance molecular mapping of the gene for virulence to H13. Each year Hessian flies cause millions of dollars of damage to wheat crops. The female fly lays her eggs in unfurled wheat leaves. When the eggs hatch, larvae crawl down the leaves and feed on plant sap inside the leaf sheath of developing wheat plants or at the wheat head, greatly reducing yields. This new genetic finding is important because the fly has been able to overcome resistance in wheat, forcing breeders to develop new resistant varieties about every seven years.

Crop Production and Pest Control Research,
West Lafayette, IN
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A newly found fungal gene holds promise for protecting plants from scab disease, which costs barley and wheat growers millions in losses each year. In the fungus *Fusarium sporotrichioides*, scientists found a gene called TRI-R, which stands for tricothecene-resistant. This gene codes for an enzyme that protects the fungus from its own deadly tricothecene toxin, T-2, which the fungus uses in its attacks on certain plants. T-2 is not a problem in U.S. crops. But it resembles the scab-fungi toxin, called the DON vomitoxin, that can devastate U.S. wheat and barley. This toxin is made by *F. graminearum*—a relative of *F. sporotrichioides*. Information obtained by studying either fungus could lead to strategies for deactivating the fungus that causes scab in U.S. wheat and barley. Scientists placed all the genes from *F. sporotrichioides* into a collection of yeasts. Yeasts that contained the TRI-R gene continued to thrive in the presence of the

T-2 toxin. Researchers believe a gene-produced enzyme coats the toxin, making it safe for the cell. Outside the cell, T-2 regains its potency.
Mycotoxin Research, National Center for Agricultural Utilization Research, Peoria, IL
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The Cereal Disease Laboratory at St. Paul, MN, is stepping up its efforts to find new ways to combat a fungus that damaged wheat and other cereal grains. New funding will enable the lab to purchase equipment and hire two scientists to study the fungus *Fusarium graminearum*, the culprit behind head scab. The lab specializes in research on fungal diseases that attack cereal grains such as wheat, barley, oats and rye. Since 1991, head scab has caused millions of dollars in lost yields each year in the Great Plains and Midwest. The new research will focus on both short- and long-term solutions to head scab outbreaks so farmers can better cope with it. Scientists will study spores of the fungus from different regions of the United States to determine if they are genetically similar. The scientists will also continue to develop resistant varieties of crops to thwart spread of the disease and evaluate the effectiveness of farming methods such as cultivation and crop rotation to prevent future outbreaks.

Cereal Disease Laboratory, St. Paul, MN
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Scientists have identified two different types of *Cercospora zea-maydis*, a fungus that causes gray leaf spot on corn plant leaves. One type occurs throughout the corn-producing regions of the United States, while the other type appears to be confined to the eastern part of the country. The finding could prove crucial as scientists probe the genetic makeup of the fungus to learn more about its virulence and develop corn varieties resistant to both types. The fungus produces spores called "conidia" that can survive the winter in crop residue left on the soil surface. The next spring, when the spores emerge, they're blown by wind or splashed by rainwater onto crops. A severe infestation can reduce corn yields by 25 per-

cent. Grey leaf spot first appeared in southern Illinois in 1925, but became a serious problem in the mid-1980s as farmers switched to tillage systems that leave crop residue on the soil surface. Since then, the disease has spread across the Cornbelt.

*Crop Production and Pest Control Research,
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Animal Productivity

Vaccinating laying hens for a respiratory disease need not lower egg production. Mycoplasmosis, a serious respiratory disease of poultry, is caused by a tiny bacterium that can easily be controlled by vaccination. It affects about 80 percent of all laying hens, which must be vaccinated or they will lose 15 eggs per hen each year. Vaccinating laying hens at 18 weeks of age cuts egg losses to only 8 eggs a year compared with nonvaccinated birds. New ARS studies show that the timing of the vaccination is critical. No eggs are lost if the hens are vaccinated at 10 weeks of age—before egg laying begins. This change maintains yearly egg production of about 253 eggs per hen. The corrected timing could amount to a production increase of \$82 million a year for the U.S. egg industry. Its annual egg sales are about \$3.8 billion.

Poultry Research, Mississippi State, MS

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Studies by ARS and university scientists show for the first time that dogs can be a host of the calf-killing parasite *Neospora caninum*. The studies also confirm a suspicion that dogs can shed the parasite in their feces. A *Neospora*-infected dog could transmit *Neospora* to cattle by defecating on pasture where the cattle graze or on or near the cattle's stored feed or hay. In California, where herd infection rates are particularly high, *Neospora* is the chief culprit in calf abortions, costing the dairy industry about \$35 million annually. Until recently, the only known site of transmission was between the cow's placenta and her fetus. But in a series of experiments, scientists successfully recovered different growth stages of *Neospora* from dogs. They recovered mature parasites as well as juvenile forms encased in oocysts, spore-like capsules that dogs can pass in their feces. On the farm, producers may want to store feedstuffs in closed containers or fence off feedlots or choice

pasture where dogs may defecate. No antibiotics or vaccines are available for treating infected cows. Producers typically cull infected animals, a practice that can be costly. In puppies, severe *Neospora* infection causes paralysis and death. Mature dogs generally are more tolerant of an infection.

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Turkey breeders will be able to single out potential sires with a technique that examines how well sperm swim. The test objectively measures what's called sperm mobility—how well sperm from each male can swim into a solution at body temperature. The test mimics the environment the sperm encounter in the hen's reproductive tract. ARS scientists in collaboration with Oregon State University scientists modified the test for turkeys. Essentially 100 percent of all turkeys produced annually in the United States are conceived via artificial insemination. With advances in genetic selection, adult turkey toms can weigh up to 85 pounds. A hen, however, weighs only around 20 pounds when she begins to lay eggs. This size difference and the efficiency of artificial insemination have resulted in breeders relying solely on artificial insemination for reproduction of their turkey flocks. Sperm are generally pooled from up to 10 to 15 males. It had been assumed that all of these males would produce similar number of offspring. However, ARS scientists in collaboration with scientists at Tuskegee University in Alabama found that a majority of offspring were produced by few males. So it's critical to determine why paternity efficiency differs so greatly between individuals. In the past, most semen evaluation tests have not predicted fertility potential of sires. The Sperm Mobility Test is predictable. By sorting out infertile toms, turkey breeders could potentially save millions of dollars annually.

*Germplasm and Gamete Physiology Laboratory,
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Beef cattle herd replacements may be raised less expensively without affecting their performance as cows. The key: Reduce their feed and defer some of their weight gain until grass is available during breeding season. In a study that included 1,275 crossbred heifers from seven breeds of sires, the most heavily fed heifers gained about a 1.5 pounds per day between weaning and breeding while those fed 20

percent less gained about 1 pound. Differences between the two groups' rate of gain reversed during the breeding season, when heifers were allowed free access to grass. Heifers that had been fed the moderate level gained 0.4 pound per day more than heifers that had been on the high level of feed. Depending on sire breeds, heifers differed in their age at puberty, age at calving, milk production and weaning weight of their calves. Prebreeding feed level had no influence on these traits.

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Soil, Water and Air Quality

Cleaning up sediment in some Maryland waterways could also benefit the state's soils. Under a new trust agreement with the Maryland Port Authority, ARS will find new ways to recycle the 5 million cubic yards of dredge spoils removed each year from the port of Baltimore and its estuarine tributaries. ARS scientists are considering poultry litter as a potential additional ingredient to turn the spoils into a soil substitute. Dredge spoils have a head start on becoming a soil substitute, because they originated as soil eroded from land and deposited on lake, ocean, bay and river bottoms. But the spoils have a low organic matter content. Adding poultry litter would remedy this, and the supply is plentiful: Each year, Maryland produces an estimated 339,000 tons of poultry litter. The spoils have two other problems: salt and acidity (low pH). The dredge spoils pick up salt in estuarine environments around the Chesapeake Bay. To counteract this salinity, scientists will search for ways to leach out the salts so the spoils can be applied to land. The spoils also become highly acid when they're removed from the water and exposed to air. To reduce the acidity, the researchers will test adding calcium-containing ash and gypsum byproducts from electric power plants. The University of Maryland's Wye Institute will field-test recommendations expected to emerge from the spoil-to-soil experiments in the next two or three years. If successful, the methods could be applied to sediment dredged from ports anywhere, including fresh and saltwater ports.

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Constructing artificial wetlands in streams can improve water quality by removing nitrogen that otherwise would continue downstream. As a test, scientists with ARS and North Carolina State University, Raleigh, built an in-stream wetland 600 yards long and 60 yards wide. The scientists stabilized the wall of a beaver dam along the stream to create the wetland. The water was 6 feet deep at the wetland's lower end, but much of it was less than 2 feet deep. About 40 percent of the 8-acre wetland was covered by aquatic weeds; another 40 percent was mainly trees. The wetland's area was less than 1 percent that of the watershed that drained through it. Yet it lowered the amount of nitrate-N in the stream by about 40 percent. The reduction was highest in warm months, when wetland inflow water was high in nitrate-N level (about 7 parts per million) but outflow was less than 1 part per million. The nitrate was likely being taken up by the plants (trees and weeds) or denitrified—changed to gaseous nitrogen by beneficial bacteria that thrive under low oxygen conditions. Dissolved oxygen in wetland water was generally less than 50 percent saturation with little or no oxygen in sediment. The project in the Herrings Marsh Run watershed in Duplin County, NC, was part of a USDA Water Quality Demonstration Project in the Coastal Plain of North Carolina.

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During the summers of 1996 and 1997, ARS scientists assisted in a study that matched frog breeding calls in farm ponds and wetlands on Maryland's Eastern Shore with the timing of pesticide applications on adjacent crop fields. The multi-agency study, funded by USDA's Natural Resources Conservation Service, is part of an investigation into the potential role of pesticides in amphibian decline in Maryland and elsewhere. An NRCS biologist identified the species by recording the males' nighttime mating songs and seining the ponds for tadpoles, while the ARS scientists sampled the pond water for 20 major pesticides. Out of the 7 to 10 species found in ponds, the breeding period of tiny green tree frogs, southern leopard frogs and green frogs best coincided with routine pesticide applications. This puts their tadpoles at the greatest risk of toxic effects from spray

drift or surface water runoff. To verify the field findings, the scientists have applied the commercial pesticides Bicep and Lorsban at common application rates to 21 lab aquaria with green tadpoles living in them, at the Patuxent Wildlife Research Center, U.S. Department of the Interior, Laurel, MD. They also applied the pesticides to 12 outdoor experimental ponds at the Patuxent center. Green tree frogs, green frogs and southern leopard frogs live in these ponds. The scientists chose Bicep, a herbicide, because its active ingredients are atrazine and metolachlor, two herbicides commonly applied on farms and detected in the farm ponds and wetlands. Lorsban was chosen because it contains chlorpyrifos, a commonly applied insecticide. Preliminary results reveal that combined application of the herbicide followed by the insecticide, at typical farm application levels, can cause impaired development, delayed metamorphosis and up to 100-percent mortality of wild tadpoles.

Environmental Chemistry Laboratory, Beltsville, MD
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A new tool for decontaminating soil could come from a genetically engineered "cousin" of natural *Rhizobium* bacteria discovered on alfalfa plant roots by ARS scientists. The altered *Rhizobium* species, *R. meliloti*, secretes enzymes that break down environmental contaminants called hydrocarbons. Some of these, like toluene and benzene, are commonly found in fuel, solvents and other prod-

ucts. But such hydrocarbons become hazardous waste once they enter the environment. Engineering *R. meliloti* for toxic clean-up duty is the work of scientists at ARS; Howard University, Washington, D.C.; the University of Maryland-Eastern Shore; the National Institutes of Health; and the U.S. Army Corps of Engineers. The Corps is funding the work in search of new, environmentally friendly methods of restoring contaminated soil at military bases and elsewhere. Conventional techniques, like excavating soil, are costly and often impractical. In greenhouse studies using alfalfa, the altered bacteria partially degraded a salt-form of toluene called meta-toluate at concentrations of 136 parts per million, a fairly toxic level. Unlike a human clean-up crew, the microbes need not fear the potential for respiratory and neurological harm from toluene exposure. Scientists also are testing the bacteria's ability to degrade dinitrotoluene, or DNT. Used to make plastic, DNT poses an environmental hazard since it doesn't readily decompose.

Molecular Plant Pathology Laboratory, Beltsville, MD
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Industrial (Non-Food) Products

Bacteria discovered in North Carolina offer new possibilities for biofuels and environmentally sound farming. The bacteria are large; a specimen discovered at a Raleigh sewage plant is four to five times the size of typical soil bacteria. The other bacteria were found in ponds, streams, soil and salt marshes. In recent years, bacteria have taken on new significance. For example, until 1980, science said molybdenum was essential for nitrogen fixation—a process that boosts soil nitrogen levels and improves crop fertility. Then an ARS researcher found that a bacterium, *Azotobacter vinelandii*, can fix nitrogen without molybdenum. The newly discovered North Carolina bacteria also can fix nitrogen without molybdenum. And they release hydrogen that could be collected and harnessed as biofuel. Chemical analysis of the new microbes shows they are unlike any other previously recorded. Researchers are now working to give them a genus and species designation. Studying the biochemical mechanisms within the bacteria could lead to more economical and environmentally friendly ways to produce nitrogen fertilizer.

*Soybean and Nitrogen Fixation Lab, Raleigh, NC
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Sunflower-oil-derived lubricants may be churning inside automobile crankcases of the future. Scientists have made compounds called estolides from oleic acids found in sunflower oil. Estolides are unique fatty acids that researchers made by chemically altering the oleic oils. The estolides can be used as a base in lubricants like hydraulic fluids. Although these fluids are classified as lubricants, their primary purpose is to transfer pressure in machinery to activate motion, not to lubricate mechanical systems. The use of sunflower-derived estolides has allowed researchers to develop the first biodegradable hydraulic fluid targeted for commercial use. Estolides also have applications in textiles, detergents, personal care products and pharmaceutical products. Estolides of the future may be made from high-oleic-acid soybeans.

*National Center for Agricultural Utilization Research,
Peoria, IL
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A new type of instantly soluble cornstarch could replace petroleum-based additives in industrial processes. Many industrial additives are made from nonrenewable sources—some toxic to humans.

ARS scientists have now developed a substitute from cornstarch, a renewable source that's less expensive and less hazardous to workers. Industry has used oxidized cornstarch for many years, but most types are not water soluble. To create highly water-soluble cornstarch, scientists mixed it with hydrogen peroxide and then dried it at high temperatures with a copper-iron catalyst. This process removes hydrogen, making the starch water soluble. This oxidized starch, mixed into compounds like cement, absorbs excess water created by chemical reactions that occur when concrete is blended with water and other chemicals. It replaces more hazardous chemicals like cyanide-based drying products used in cement. Other possible uses for the new oxidized cornstarch include binding calcium, magnesium and iron in repulping wood fibers for paper; replacement of formaldehyde in adhesives; and coating crop seeds.

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New markets for soybeans, canola and meadowfoam could spring up more quickly in the future. That's because of a new ARS test and protocol that will help speed development of industrial lubricants from vegetable oils. More than 10 percent of hydraulic fluids and other industrial lubricants now made from synthetic and petroleum-derived oils could be replaced with vegetable-derived products. Current lab tests require at least a gallon of fluid and can take 5 weeks. The new test takes one week and uses only two ounces of fluid to check hot and cold temperature performance, friction, corrosiveness, flammability and other characteristics. From a check of 50 vegetable-derived base oils, the researchers selected three that perform as well as petroleum-made lubricants. The research was done under a cooperative research and development agreement with Caterpillar Tractor Company, Peoria, IL.

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Computer Systems and Models

Breeders can save time evaluating wheat lines with commercial potential by tapping into a database developed by ARS and South Dakota State University researchers. The database holds milling and baking quality data from hundreds of hard winter wheat lines grown at federal breeding nurseries that USDA has managed throughout the Great Plains since 1991. Breeders can home in on a wheat line's major quality deficiencies and rank each one based upon milling and baking quality. The user-friendly Windows database allows breeders to select icons with pull-down menus. The Regional Performance Nursery Relational Database is provided free of charge by the USDA. The database may be found on the Internet at <http://gqu1.usgmrl.ksu.edu/gquHWWQLcrop%20reports.html>.

Hard Winter Wheat Quality Laboratory, Manhattan, KS
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Thirsty cotton plants can easily be detected by aircraft-mounted sensors shortly after thirst sets in, an ARS study in a central California cotton field confirms. Scientists put the sophisticated sensors through this test because they anticipate farmers in the future may increasingly rely on imagery from these or other instruments, mounted on aircraft and satellites, to monitor crops. The instrument package included three multispectral digital cameras that detect light in different wavelengths and a thermal infrared sensor that detects heat. Imagery from all sensors is processed through a computer. The study—a collaboration by ARS scientists in California and Arizona—is one of the first to show that scrutinizing imagery from both kinds of instruments may be the best way to sidestep inaccuracies possible when thermal imagery alone is used to find thirsty plants. Scientists turned off irrigation valves for their research field to simulate real-life situations in which irrigation pipes can become blocked or automated schedulers malfunction.

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Quarterly Report

of Selected Research Projects

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Into the Marketplace

Farmers and land managers can now determine—right in the field—whether their soils contain too much salt or sodium, thanks to a new commercial test kit based on ARS research.

Standard salinity and sodicity tests performed by a laboratory require collection and shipment of soil samples. Getting the results may take up to 2 months at a cost of \$50 per sample. The new test relies on electrode measurements rather than chemical analysis and gives results in 5 minutes for about \$3 per sample. The kit also includes easy-to-use computer software and a manual to help users take steps to improve their soil quality. Approximately 30 percent of irrigated land in the United States and 50 percent worldwide is affected by salt. Soil salinity increases as irrigation or drainage waters evaporate and leave salts behind. Sodic soils are those with too much sodium relative to their cal-

Contact the scientists listed for further information on each research project. For general questions about this report, contact Hank Becker, ARS Information, 5601 Sunnyside Avenue, Beltsville, MD 20705, (301) 504-1624, hbecker@asrr.arsusda.gov

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This publication is available on the World Wide Web at <http://www.ars.usda.gov/is/>

cium and magnesium content. Both conditions hinder plant growth and reduce crop yields. The test was developed under a Cooperative Research and Development Agreement between ARS and the Hach Company in Loveland, CO.

U.S. Salinity Laboratory, Riverside, CA

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Guardian, a new peach tree rootstock, has begun helping growers battle the leading cause of peach tree death in the Southeast.

Peach tree short life (PTSL) costs growers about \$10 million annually. It strikes in the spring, usually when the trees are three to seven years old. ARS and Clemson University scientists codeveloped Guardian, which proved its value during its first field tests from 1989 to 1996 in South Carolina and Georgia. Scientists planted trees on Guardian rootstock and compared them to trees grown on two commonly used commercial rootstocks, Lovell and Nemaguard. Lovell has tolerance to PTSL; Nemaguard resists root-knot nematodes. Guardian has a unique combination of resistance to both problems. By 1996, no Guardian trees were lost to PTSL in test orchards in South Carolina, and only 20 percent were lost in Georgia. By contrast, 97 percent of the Lovell trees in South Carolina died, and 40 percent died in Georgia. For Nemaguard, 95 percent of South Carolina's trees and 80 percent of Georgia's succumbed to the disease. ARS and Clemson University have jointly applied for a plant variety protection certificate on Guardian rootstock, which is available only through licensed nurseries.

Southeast Fruit and Tree Nut Research Laboratory, Byron, GA

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Charleston Greenpack southernpea is a new, high-yielding, pinkeye-type southern pea developed for the frozen food industry.

Unlike conventional pinkeye peas, Charleston Greenpack is the first pinkeye-type variety developed that has green cotyledons or first leaves, so dried peas have a persistent green color. ARS scientists developed the new variety

under a Cooperative Research and Development Agreement with Western Seed Multiplication, Inc., of Oglethorpe, GA. The new pea plants grow low and bushy, producing pods in 62 to 69 days. Each pod, about 6 inches long, holds 14 peas—more than the two leading southern pea varieties. In the southeastern U.S., Charleston Greenpack can be planted in spring, mid-season or fall. Dry peas are light olive in color, have a smooth seed coat and are small: 100 weigh about 1/2 ounce. Blanching in boiling water restores the dry peas to a near-fresh green color. The new pea also proved highly resistant to blackeye cowpea mosaic virus, one of the biggest threats to pea crops. In 1996, Charleston Greenpack performed well in farm trials in Georgia and Florida conducted by Western Seed. Western Seed has an exclusive license to market the new cultivar. Its attractive appearance when frozen has caught the eye of frozen food processors and created a substantial demand for seed. The new pea is suitable for use by home gardeners. Limited quantities of seed should be available to them by spring of 2000.

U.S. Vegetable Laboratory, Charleston, SC

Richard L. Fery, (843) 556-0840, rfery@awod.com

Cooperative Research and Development Agreements

...With Sterling International Inc., of Veradale, WA, to develop the best delivery system for a new insect attractant. ARS developed the lure, the first to work on German yellowjackets, golden paper wasps, European hornets and several other species. Commercial traps could be available in a year. Yellowjackets and wasps can be dangerous to workers and others in fruit orchards during picking season; as well as around parks, residential yards and other areas. The stings can cause a potentially dangerous allergic reaction in some people. The new lure could provide a means of monitoring and controlling the insects. It uses acetic acid and isobutanol, which combine to create an odor desirable to many species of yellowjackets, at least three species of paper wasp and a hornet. Five of the 17 U.S. yellowjacket species are considered significant pests. (PATENT APPLICATION 09/041,056)

Yakima Agricultural Research Laboratory, Wapato, WA

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...With ATO-DLO, a Dutch institution in Wageningen, The Netherlands, to develop ways to make commercial products with high-grade protein gels. ARS scientists produced these gels from chrome shavings that are waste products of

cattle hide tanning. Using alkaline protease, a common laundry detergent enzyme, the ARS researchers produced a protein gelatin that can be used in making adhesives, industrial films for packaging, and encapsulating agents for industrial and agricultural chemicals. The high-grade protein is equal—and in some cases superior—to commercially produced gelatins. Tanners get only 50 pounds of leather from 100 pounds of cattle hides, leaving 50 pounds of waste. They tan hides into leather with nontoxic chromium-III sulfate, then shave the bottom sides of the hides to give them a uniform thickness. As a result, each year about 60,000 metric tons of chrome shavings end up as waste bound for landfills. Scientists also purified the chromium left over after the proteins were removed and reused it as an agent in the tanning process. The quality of the leather they produced is comparable to commercially tanned leather. The scientists have also found a way to recycle the enzyme used to extract the proteins. A modified version of the process, for which ARS holds two patents, is being used in a tannery in the Czech Republic. (PATENT 5,094,946 and 5,271,912)

Eastern Regional Research Center, Wyndmoor, PA

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...With Engelhard Corp. of Iselin, NJ, to develop and commercialize new technology that reduces the chemicals needed to control plant pests and diseases. In the new process, researchers spray specially sized and shaped microscopic mineral particles on plants to form a protective film. The coated plants require less pesticide and may have improved health and better fruit quality. Over time, particle film technology may also improve soil condition. The technology has been tested against several insects, mites and fungal diseases. It works on tree fruit crops and has potential on vegetable and field crops. Engelhard has filed four patents, including foreign patent rights, with ARS as co-owner. Prototype films are made by modifying kaolin, a naturally occurring mineral that is generally regarded as safe (GRAS). Approved by the Food and Drug Administration as an indirect food additive, kaolin doesn't harm earthworms or beneficial insects and doesn't affect crop pollination. The U.S. Environmental Protection Agency has approved applications for registration of three prototype products. Products should be commercially avail-

able in 1999 in parts of the United States for use on apples and pears and will be cost-competitive with conventionally used chemicals.

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...With Artlo Industries, Inc., Perris, CA, to develop, test and commercialize lightweight concrete products made with a surprising ingredient—wheat starch. ARS scientists will provide samples of the wheat-based aggregate to make the concrete and will also help develop specifications for commercial products. Artlo Industries will determine whether the concrete is suitable for making exterior panels for high-rise office buildings and other precast concrete products for businesses and homes, including planters, fountains, tables and benches. The company will also test formulations for strength and durability and determine the most cost-effective ways to use the aggregate. The 35 artisans and others employed at Artlo Industries design and manufacture precast concrete products for large construction corporations, as well as architectural, design and engineering firms. (PATENT 5,595,595)

*Western Regional Research Center, Albany, CA
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...With CRC Press, Boca Raton, FL, to publish information on genetically transforming insect species of agricultural and medical importance. Several authorities in the field of insect transformation will contribute to the book, which will provide the latest ideas and methodologies in this field. Genetic modification of insects is accomplished by moving or introducing new genes into the chromosomes. The publication will present existing and potential methods for various types of insect transformation so other scientists can understand potentials and pitfalls relevant to insect species they're studying. ARS scientists contributing to this publication have successfully transformed the Mediterranean fruit fly (*Ceratitidis capitata*), an economically important worldwide pest that feeds on many fruits and vegetables. The fly is a quarantine pest on the U.S. mainland. The ultimate goal of ARS' research is to create transgenic strains for genetic-sexing and male sterilization for sterile release programs and monitoring.

Center for Medical, Agricultural and Veterinary Entomology, Gainesville, FL

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Patents

A new bait developed by ARS scientists to lure Mexican fruit flies will soon be available to growers. Improved baits and traps give action agencies new tools to detect fruit fly invasions sooner and prevent the pests from spreading. Mexican fruit flies, important quarantine pests of citrus and many other crops, are strongly attracted to the new synthetic lure. It resembles the pests' natural protein food source and has three chemical components: ammonium acetate, putrescine and methyl butanol. In several years of field trials in Guatemala, ARS scientists compared sticky cylindrical traps baited with the new lure versus glass McPhail traps baited with liquid protein currently used to detect fruit flies. The new lure caught almost twice as many insects as the standard lure. It also was more effective at capturing both males and females. And compared to the sticky trap, McPhail traps are fragile and cumbersome. Female Mexican fruit flies lay eggs in at least 36 different fruits. In the U.S., the pests could potentially cost \$1.4 billion a year in export losses, crop yield reductions and treatment expenses. The flies periodically cross the Mexican border to infest U.S. fruit orchards, most often in the Lower Rio Grande Valley in Texas. (PATENT APPLICATION 09/156,625)

Center for Medical, Agricultural, and Veterinary Entomology, Gainesville, FL

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ARS plant breeders are a step closer to achieving a longtime dream—producing corn that maintains its high yields and desirable traits with each generation. Today's hybrid corn only retains its hybrid vigor and genetic traits for one generation. This means farmers must buy and plant new hybrid seed each year. The scientists' goal: to transform corn from sexual reproduction that requires pollination to an asexual form of reproduction called "apomixis." Apomixis would enable corn plants to produce seed that are exact copies or clones of the parent seed. The ARS scientists are using classical and molecular breeding to transfer the gene for apomixis from eastern gamagrass (a self-pollinating relative of corn) to corn. In earlier research, a team of ARS, Russian and Moldovan scientists successfully transferred a segment of an eastern gamagrass chromosome, carrying the apomixis genes, to an intact chromosome of maize. The resultant crop looks, grows and tastes like corn. The team has now

obtained the first patent on apomictic corn. In its attempt to isolate genes controlling apomixis, the team has amassed an extensive genomic library of more than 215,000 clones (or segments of genetic material called DNA) from both corn and eastern gamagrass. The library covers more than 94 percent of both the corn and gamagrass genomes. The researchers say there's a high probability of success for isolating the apomictic genes. Once the scientists have isolated and confirmed these genes, they will seek another patent on the gene or genes responsible for this trait in corn. Then seed companies will be able to license these genes and insert them into any line of corn, wheat, sorghum and rice. The achievement would profoundly change the future of agriculture by significantly reducing the high cost of producing hybrids as well as the expense of land use, personnel and equipment. (PATENT 5,710,367) *Southern Plains Range Research Station, Woodward, OK Bryan Kindiger, (405) 256-7449, bkindiger@ag.gov*

From ARS laboratory "kitchens" comes a new, low-cost way to make sweet potato patties and fries with improved gelling texture and more flavor. The research could add value to the nation's \$213 million sweet potato crop. It might also spell some future competition with Mom's candied sweet potatoes. Food companies have tried using sweet potatoes to make savory snacks of patties and fries. But some consumers found the snacks gummy, possibly because of the starch holding them together. A taste panel found that the new formula yields products with a taste more like that of fresh-baked sweet potatoes. A taste panel also evaluated three puree methods the industry uses for preparing sweet potato products. The panel picked slicing and slow-cooking the sweet potatoes before making puree as preferable to using either flash-cooked or raw sweet potatoes. With the new formula, companies could use sweet potatoes that have high taste qualities but normally would be discarded due to less than perfect shape or size. (Patent application pending)

Food Science Research Laboratory, Raleigh, NC William M. Walter, Jr., (919) 515-2979, wmwalter@ncsu.edu

Soil, Water and Air Quality

Sometime in the past 15 years, American farmers crossed an auspicious environmental boundary: They began reducing the level of atmospheric carbon dioxide rather than adding to it. CO₂ is one of the greenhouse gases thought to cause global warming. A new ARS study shows that U.S. farm-

ers have shifted from being net producers of carbon dioxide to net accumulators of carbon, in the form of valuable soil organic matter. An ARS soil scientist discovered the difference after a thorough search of published reports and surveys for several major crops and comparing 1940 to 1990 conditions. The analysis, aided by other research nationwide, showed the changeover was due largely to farmers' increasing abandonment of a cherished symbol of past American agriculture, the moldboard plow used to break up the prairies. By 1993, farmers used moldboard plows on only 6 to 9 percent of wheat, soybean and corn, according to USDA statistics in the study. The plow inverts soil to a depth of 8 to 12 inches. The inversion buries recent stubble and other unharvested crop residue deep into the plow layer, where microbes tend to decompose it into carbon forms easily converted to CO₂. This CO₂ can escape to the atmosphere. As farmers put aside the moldboard plow, they leave nearly all of the residue on the soil or within a depth of 4 inches. For example, corn and grain sorghum farmers are returning twice as much crop residue to the surface as there was in 1940. Here, the residue readily decays to organic matter, a more stable carbon compound and a key property of the black, fertile prairie soil.

Soil and Water Management Unit, St. Paul, MN Raymond R. Allmaras, (612) 625-1742, allmaras@soils.umn.edu

A new and improved tool developed by ARS scientists swiftly measures a field's soil strength, giving farmers and researchers a quick way to tell if plant roots will have a hard time pushing down into the soil. This information helps farmers decide what type and depth of tillage is best for their fields. The new multiple-probe soil cone penetrometer tests soils for compaction or layering that restricts root growth. Dense, high-strength soil tends to confine root growth. Heavy agricultural equipment can also cause this condition. Loose, low-strength soil provides the best condition; it lets roots penetrate downward and reach moisture during summer dry spells. The tractor-mounted probe measures soil strength across an entire row in about 1 minute—a great timesaver. Manual one-probe devices require five insertions to obtain the same data and can take 10 minutes per row. Another improvement: The new version is more sensitive than previous models. It reads depth to the millimeter and penetration force to within 0.1 pound per square inch. ARS scientists have used the device to measure soil compaction in several soils throughout the Southeast.

National Soil Dynamics Laboratory, Auburn, AL Randy L. Raper, (334) 844-4654, rlraper@eng.auburn.edu

A hairy vetch cover crop and corn residue left from not plowing create a double mulch for crop fields, saving on chemical weed killers and commercial fertilizers. This double mulching keeps soil moist and smothers grass weeds, the principal weed type in farm fields. Preliminary data from 1998, the second year of a 3-year study at Beltsville, MD, suggest the practice could reduce the amount of atrazine used nationally to control grass weeds. American farmers use 250 million pounds of atrazine annually. Atrazine is a pre-emergent herbicide—that is, it's used as a precaution before planting. It and other pre-emergent herbicides are potentially more of an environmental hazard than postemergent herbicides, used when weeds appear after planting. Preliminary results of assessing herbicide fate in no-till corn also indicate that hairy vetch reduces the loss of herbicides in runoff, but several years' data will be needed before a quantitative value can be given. The researchers' data also show that nitrogen-producing cover crops like hairy vetch can reduce nitrogen fertilizer use without sacrificing yields. Similar preliminary findings from an ARS demonstration project at Beltsville suggest that the hairy vetch system is most profitable to farmers. The new data show that vetch also reduces downward leaching of metalochlor, a common herbicide for cornfields. The next phase of the study, to run 5 additional years, is named CIMASS, for Cover Crop Impact on Nitrogen and Weed Dynamics To Minimize Agrochemical Use in Sustainable Systems. This phase will lead to detailed recommendations on how farmers can rely more on postemergent herbicides and apply other cost-effective techniques to control weeds with the least loss of herbicides to the environment. Commercial herbicide-resistant corn varieties will be tested.

Environmental Chemistry Laboratory, Beltsville, MD
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Weed Science Laboratory, Beltsville, MD
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An ARS-designed rainfall simulator has been setting the stage for what will probably be the largest outdoor study of the movement of coliform bacteria and *Cryptosporidium parvum*, a protozoan parasite, in rain runoff and soil water. The simulator has a boom that flexes as the land's slope changes, keeping the "rain," the same distance from the soil up and down the slope. The simulator will help scientists trace water movement to track possible routes for bacterial pathogens and for *C. parvum*, which caused an outbreak of illness from

drinking water in Milwaukee in 1993. The study uses two of six lysimeters built by the U.S. Nuclear Regulatory Commission to study storage options for low-level radioactive waste. These lysimeters are giant blocks of soil isolated for contained outdoor studies. The NRC used empty tanks as stand-ins for radioactive waste and turned the sites over to ARS after the experiments were finished. Each lysimeter is above the water table and lined with plastic to prevent soil water from leaching in or out. Each is about 70 by 40 feet square and 10 feet deep. ARS scientists are testing two different soils and two different slopes in the lysimeters. From earlier studies, the ARS scientists have preliminary data indicating that bacteria are more likely to be a problem in groundwater, while *Cryptosporidium* is more likely to contaminate surface waters. Next year, the scientists will begin adding *Cryptosporidium* in manure and monitor its movement, along with that of native coliform bacteria which will be used as surrogates for pathogenic bacteria such as *E. coli* O157:H7, which has caused foodborne illness.

Environmental Chemistry Laboratory, Beltsville, MD
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A new device called a biosensor will help farmers and regulators detect herbicides in soil and water. In only minutes, the new invention identifies traces of herbicides residues by using a chlorophyll-protein reaction center complex that measures oxygen levels. To use the biosensor, the farmer or regulator passes a soil or water sample through the device. If the sample solution contains an herbicide, the chemical will react with the biosensor's proteins and inhibit oxygen production. This information is relayed to a computer, which displays the data in graph form. The biosensor can only measure herbicides that inhibit photosynthesis, such as diuron, atrazine, simazine, ioxynil, bromoxynil and dinoseb. This group of herbicides constitutes about 50 percent of all herbicides used in agriculture. The test is ultra-sensitive. Its detection limits are similar to or slightly better than the more complex, highly sensitive ELISA test, which is antibody-based. The biosensor works well at room temperature. Its membrane is stable for up to about 40 hours and can be reused within that period for any number of measurements. ARS scientists codeveloped the biosensor with scientists from the Czech Republic and Italy through a grant supported by the North American Treaty Organi-

zation. Once commercialized, it should be economical and easy to use—distinct advantages over currently available herbicide detectors.

Vegetable Laboratory, Beltsville, MD

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ARS-designed seed-delivery packages could be an inexpensive, natural way to revegetate overgrazed and desertified land, such as areas in the Jornada Experimental Range in New Mexico. The Jornada is in the northern part of the Chihuahuan Desert, one of the driest spots in the country and the largest desert in North America. In each package, seeds are tucked into three little pipes, which in turn are set within a larger pipe. The packages, which cost 75 cents each, are staked in rills often less than 4 inches deep to await a rare event in the Jornada: rain. If enough rain falls, a streamlet with sufficient force will break through crepe paper covering both ends of the lowest seed pipe. Seeds then flow out through a mesh screen on the end of the outer, larger pipe. If the rain continues, the streamlet rises, freeing seeds from the middle pipe—and so on. Seed is released only when rain falls. This ensures that all the seed is released only when there is enough rain to spread it far downstream. The rain also ensures that seeds are deposited in moist soil with a mulch cover of grass stem litter naturally carried by streamlets. The scientists are monitoring results to see if stream-seeded plants eventually spread to cover large areas of bare ground.

Jornada Experimental Range, Las Cruces, NM

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Food Safety and Quality

Beneficial strains of fungi are the star players in a new anti aflatoxin program planned for spring of 1999 on 20,000 acres of Arizona cotton. Certain strains of *Aspergillus flavus* fungi and related fungi produce aflatoxin, a potential carcinogen. In Arizona, aflatoxin contamination costs cotton growers an estimated \$3 million to \$8 million each year. The campaign against it depends on ARS-developed technology. Under an experimental use permit from the U.S. Environmental Protection Agency, farmers will apply beneficial fungi as a biopesticide. Developed by ARS scientists, these fungi are atoxigenic—nonaflatoxin producing—strains of *A. flavus*. When applied to the soil beneath cotton plants, the good-guy strains crowd out or exclude the bad-guy *Aspergillus* from choice nutrients and space. This undermines the bad fungi's ability to spread to the crop and produce aflatoxin. Federal law prohibits

cottonseed with more than 20 parts per billion of aflatoxin from being fed to dairy cattle. Until recently, cotton farmers could do little to reduce contamination, other than harvest crops early and control insects that spread the fungi. ARS has tested the new approach, called "competitive exclusion,,, on more than 1,100 acres of cotton since 1996. The tests show that the approach reduces contamination by 90 percent. To expedite Arizona's program, ARS scientists supplied EPA with 1,200 pages of scientific data on the safety and efficacy of the atoxigenic fungi.

Southern Regional Research Center, New Orleans, LA

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New high-tech tests more quickly detect a key organism that can cause food poisoning.

ARS researchers developed the tests to detect Shiga-toxin-producing *E. coli* (STEC) strains, such as *E. coli* O157:H7 in cattle feces and beef. These bacteria form toxins and other proteins that contribute to diarrhea in infected animals. The new test uses a technique called fluorescent PCR (polymerase chain reaction). In this process, scientists first amplify the organism's DNA using PCR. Then they use a fluorescent detector to illuminate the DNA. Results from the test can be obtained within 4 hours, which is 4 to 8 hours faster than other laboratory procedures. The researchers tested more than 60 strains, demonstrating 100 percent accuracy in detecting STEC and distinguishing *E. coli* O157:H7 from other STEC strains. These tests will be useful to cattle producers and veterinarians for fast diagnosis of diarrhea caused by STEC bacteria in calves. Cattle producers need this information to meet federal restrictions against the presence of *E. coli* O157:H7 on animal carcasses. The bacteria are transmitted to humans who eat foods contaminated with infected animal feces. About 20,000 human cases of *E. coli* O157:H7 infection are reported annually in the U.S., according to the Centers for Disease Control and Prevention.

National Animal Disease Center, Ames, IA

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A simple three-step process can help poultry producers keep *Salmonella* and other food pathogens out of poultry—and may increase profits, according to an ARS trial in cooperation with a Georgia poultry producer. Each step blocks contamination at a critical point in the bird's life cycle. Farmers would spray freshly laid eggs with a mild detergent and a reliable farm disinfec-

tant chemical; hatcheries would spray a fine mist of hydrogen peroxide in the cabinet while chicks are hatching; and young chicks would receive benign gut bacteria from healthy mature chickens to prevent *Salmonella* colonization in the grow-out house. Working with a farmer, an ARS researcher confirmed the effectiveness of the first step. This producer found cleaning and disinfecting eggs paid for itself because more eggs were sold at a higher price. Estimates are that a large-scale farm selling millions of eggs annually could recover the cost of the spraying equipment in 2 years.

Richard B. Russell Agricultural Research Center, Athens, GA
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Animal Production and Protection

Several proteins that probably help a biting gnat transmit bluetongue, a virus of cattle and sheep, have now been pinpointed by ARS scientists. The gnat, *Culicoides variipennis* (KOO-lee-coy-deez vary- uh-PENN-uss), is also called a biting fly, midge or, because of its small size, a no-see-um. The gnat proteins increase blood flow to the bite area, prevent aggregation of platelets needed to close off the wound, and inhibit immune system cells that would help a victim fight off the virus. Researchers already knew about similar proteins in other biting insects and ticks. But the ARS team is the first to show that *C. variipennis* secretes these specialized molecules from its salivary glands. The proteins may prove to be a better tool than the virus itself for use in developing a bluetongue vaccine. That's because the many strains or serotypes of the virus can quickly develop resistance to a virus-oriented vaccine. This problem wouldn't occur with a vaccine targeted to the gnats' salivary-gland proteins. Bluetongue annually costs the U.S. livestock industry an estimated \$120 million in lost trade. Countries without the disease won't accept some American livestock exports.

Arthropod-borne Animal Diseases Research Laboratory, Laramie, WY
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Human Nutrition

Tomatoes chock full of beta-carotene may soon be available to consumers, thanks to the recent ARS release of three new tomato breeding lines. The new lines contain about 10 to 25 times more beta-carotene than typical tomatoes. ARS researchers developed the new lines—97L63, 97L66 and 97L97—for processing into paste, juices and sauces. Soon, ARS will also release high beta-carotene

cherry tomatoes and beefsteak-type tomatoes as specialty varieties for the fresh market. The new tomatoes are good nutritional news for consumers, because the human body converts beta-carotene into vitamin A, an essential nutrient that aids in clear vision, bone growth, tooth development and reproduction. Beta-carotene content averages 57.6, 55.1 and 55.5 micrograms per gram of fresh weight for 97L63, 97L66 and 97L97, respectively. Typical tomatoes contain only about 2 to 5 micrograms per gram. Lines 97L63 and 97L66 are adapted for California and the Eastern and Midwestern U.S. These fruits are firm and crack resistant. Tomatoes that split before harvesting are susceptible to fruit rot, which can cause large crop losses. Breeding line 97L97 is adapted for Eastern and Midwestern states. The United States is number two in fresh and processed tomato production worldwide, with Florida and California the top-producing states.

Vegetable Laboratory, Beltsville, MD

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Blueberries score highest among 50 fruits and vegetables in their ability to defuse damaging oxygen free radicals in a test tube assay. Early studies with rats suggest this antioxidant power translates to protection of cells and tissues. Now the researchers have found a three-fold difference in blueberries' antioxidant ability, depending on species and maturity at harvest. Using the ORAC assay for total antioxidant capacity, they analyzed commercial blueberry varieties and less common species from the United States and Canada. They also analyzed the closely related bilberry from Germany. Overall, the bilberry scored highest in antioxidant capacity. Lowbush blueberries from Nova Scotia and some other U.S. cultivars were quite close to the bilberry in antioxidant capacity, depending upon stage of maturity. Mature berries from two commercial rabbiteye cultivars—Brightwell and Tifblue—scored one and one-half to more than twice as high as berries picked 7 weeks earlier from the same bush. That's due to the increase in antioxidant pigments, or anthocyanins, as the berries mature. Ripe berries not only taste better; they may be more healthful. Region, however, did not affect the antioxidant score, based on analyses of berries from the northern highbush variety, Jersey, grown in Oregon, Michigan and New Jersey.

USDA Human Nutrition Research Center on Aging at Tufts, Boston, MA

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A new USDA database to be launched on the World Wide Web in 1999 will help scientists pinpoint which estrogen-like compounds in soy foods are responsible for the lower risk of cancer in women—especially breast cancer. And it will enable nutritionists and physicians to recommend the foods with the highest levels of specific estrogen-like compounds, which have also been reported to improve cardiovascular health and reduce bone loss after menopause. Compiled by ARS scientists, the database will give values for the major isoflavones in 140 soy foods and ingredients. Soy isoflavones, such as daidzein, genistein and glycitein, mimic the hormone estrogen. They also have antioxidant capability and may perform other functions that enhance health. The new soy isoflavone database will be on the same web site as the USDA Food Composition Database at <http://www.nal.usda.gov/fnic/foodcomp/>. While isoflavone values won't be given for individual brand names, commercial products were analyzed to arrive at average values for each type of food or food additive. ARS researchers evaluated and compiled some 30 scientific reports of the isoflavone content of foods. They also relied heavily on analyses done in the laboratory of a collaborator at Iowa State University in Ames to fill in missing or sparse values.

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Oatrim reduced oxidation of fatty acids in a recent study that turned up more potential benefits of this ARS-patented fat replacer made from soluble oat fiber. A daily intake of about 1/2 cup of the powdery substance added to various foods reduced an indicator of fat oxidation by 80 percent. This means Oatrim helps protect cell membranes and many other components fabricated largely from fatty acids. And, judging from an increase in the volunteers' breath hydrogen, some of the oat extract was fermented by bacteria in the volunteers' colons, producing short-chain fatty acids. These are thought to protect against cancer and reduce the risk of heart disease. The same researchers earlier reported that a daily diet containing Oatrim reduced body weight and blood lipids, and improved glucose tolerance in men and women participating in the studies. It also reduced systolic blood pressure in the men. The fat substitute is in some baked goods and cheeses as Oatrim or hydrolyzed oat flour. It is also in East Coast markets as an additive for skim milk under the brand name

Oatri-Slim. The researchers attribute Oatrim's antioxidant function to something other than its beta glucans—the soluble fibers known to lower cholesterol. That's because fat oxidation dropped about equally whether the volunteers consumed Oatrim with 1 or 10 percent beta glucans.

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Higher blood levels of a hormone called leptin is one possible reason why African-American teenage girls tend to be heavier and taller and to mature faster than their peers in other ethnic groups, a pediatric researcher has found. Manufactured only in fat tissue, leptin circulates in the blood, where scientists know that it acts as a biochemical curb on appetite. Its counterpart, neuropeptide-Y, is known to trigger hunger. If an individual has higher blood levels of leptin, it may mean the body requires more leptin to "hear," its biochemical message. Other medical research has suggested higher leptin levels may also speed sexual maturity and make the body better at conserving energy. This naturally higher energy efficiency could explain why African-American girls grow faster than their peers from other ethnic groups. But that same metabolic efficiency could backfire in adulthood, contributing to obesity and increased health risk. The ARS-funded research adds to the evidence that all girls can benefit from establishing healthy dietary and physical activity in childhood. The study was published in the October 1998 issue of the *Journal of Clinical Endocrinology and Metabolism*. The data helps fill in needed information on human metabolism in the African-American population.

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Prolina, a high-protein soybean from ARS, appears to have the right amino acid mix to make soy infant formula more like mother's milk. The new bean has an unusually high concentration of cystine, an amino acid that occurs naturally in human breast milk. Prolina has several times more cystine than regular soybean varieties. Scientists have speculated that cystine is important to brain and eye development, because the body uses this amino acid to make taurine, a compound highly concentrated in those organs. As a bonus, Prolina is rich in 11S and 7S proteins that belong to a special class of proteins with enhanced processing properties. This means it's

easier to process these beans into a gel form for a fat-free whipped cream made from soy—or to blend them into a liquid emulsion like infant formula. ARS scientists originally bred Prolina as a feed for livestock.

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Crop Productivity

ARS scientists are unraveling a biochemical communication pathway that enables plants to cope quickly with drought, heat, cold, pests and other environmental stresses. Unraveling the complete pathway—a complex chain reaction—should help scientists breed plants better able to withstand environmental stresses. ARS scientists discovered and cloned two genes for an enzyme that seems to trigger a stress signal. In plants under stress, this enzyme produces GABA, for gamma-aminobutyric acid, within minutes. The enzyme may function as a thermostat: The more stress, the more GABA is released. When stress starts to decrease, so does the GABA level. The scientists genetically modified a plant named *Arabidopsis*—a “lab rat,” of the plant world—to test GABA’s role in plant development and responses to environmental stress.

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The Asian hive bee, *Apis cerana*, stores a surprisingly large amount of an oily compound in an unexpected place—its venom sac. Scientists are interested in the compound, called eicosenol, because it may be an important ingredient in an alarm pheromone. Bees use alarm pheromones to signal other bees to attack intruders. Until now, pheromones had never been found in bee venom. Other honey bee species apparently store their pheromones in spongelike tissue at the base of their stingers. ARS scientists collaborated with British and Brazilian researchers to analyze more than 300 Asian hive bees from Hong Kong, Malaysia, the Philippines, India and Japan. They found that the honey-making Asian hive bee has 50 to 100 times more of the pheromone component than other bees studied so far. Scientists still are not certain how the *A. cerana* uses the chemical but suggest the bee might tag potential intruders, thus alerting hivemates. Further research may uncover the chemical’s value

to Asian hive bees. Those studies may also reveal ways the compound might be used in this country to help our domesticated European honey bee, *Apis mellifera*, fend off harmful mites that have devastated many U.S. honey bee colonies.

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Using hydroponics, ARS scientists have produced strawberry plants that yield as much fruit as plants grown in soil fumigated with methyl bromide. That’s good news for strawberry growers worldwide who use the fumigant to control soil-borne insects, diseases and weeds. Because the chemical has been named an ozone depletor, it will be phased out over the next several years. If an effective alternative isn’t found, annual production of field-grown strawberries will be cut dramatically in California and Florida, the major producing states. One alternative could be hydroponics—growing plants in a water and nutrient solution without soil. From hydroponically grown plants, ARS scientists harvested ripe strawberries twice a week from December to May. Fruit quality and taste were excellent, and the few foliage pests were controlled with natural agents. Growers may recoup high initial setup costs for hydroponic farming by producing a higher-value product, increasing yields and spending less money on pests and diseases. In addition, weather isn’t a factor that limits greenhouse crops, and hydroponically grown berries reduce labor costs.

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Industrial (Non-Food) Products

New waste recycling techniques could turn the discarded shells of pecans, almonds and other nuts into a prized commodity: activated carbons. Millions of microscopic pores riddle the structure of activated carbons, enabling them to adsorb many different chemical compounds and certain metals that sometimes contaminate air or water. Coal is the standard material for making the carbons, but it’s a limited resource. Now research shows that carbons made from nutshells work just as well, if not better. This could spell good news for commercial nut growers and processors. They dispose of the nutshells at high cost or sell them for \$2 to \$10 a ton as a low-value commodity such as mulch. But the

nutshells could find a niche in a global market that now consumes 600 million pounds of activated carbons annually—half of this in the U.S. Carbon uses run the gamut from fish tank filters and wastewater treatment plants to mining operations. Another application is air monitoring. In one comparative study with six commercial adsorbent products, one type of nutshell carbon resulted in a three- to four-fold increase in benzene adsorption for a standard EPA air sampling method. Benzene is used in fuels, dyes, solvents and many other products. But it becomes a contaminant upon escape into the environment. The scientists are now seeking to establish a cooperative research and development agreement with a commercial partner.

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A new textile processing technique could breathe economic life into linters—short, curly cottonseed hairs that now have low commercial value. Linters usually get shaved off the seed at the cutting mill once the longer, more slender staple fibers have been removed at the cotton gin. Staples undergo further processing and finishing for use in clothing, towels and other fabrics. Linters, however, are ground into a pulp for making paper. One reason is that linters don't readily process into a cohesive sheet, or batt, without unraveling. ARS textile engineers tackled the problem with a technique that forces linters to wrap around staple fibers in the batt. Absorbent wipes, cosmetic pads and other nonwoven products made from the new blend offer the same look, feel and quality as commercial products containing 100 percent staple fibers. Incorporating linters helps reduce the costs of raw materials and of bleaching—a key processing step. Unbleached linters cost about 18 cents per pound versus 80 cents or higher for staples. Bleached linters cost about 50 cents a pound versus \$1.35 for staples. The researchers are now seeking a commercial partner to refine the technology.

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Crop Diseases and Pests

A sensitive genetic test developed by ARS scientists will enable state and federal regulators to detect a nasty bacterial disease of citrus—if and when it invades the country. The

disease is citrus variegated chlorosis (CVC), caused by a strain of *Xylella fastidiosa* bacteria. Some 88 million orange trees in the state of Sao Paulo, Brazil—a major source of orange juice for U.S. consumers—are infected with *X. fastidiosa*. Brazilian experiments show the bacteria are capable of reducing yields 37 to 100 percent, depending on the orange variety. ARS scientists developed a genetic test that distinguishes the CVC pathogen from other strains of *X. fastidiosa*, including one that infects Brazilian coffee plants. The test uses PCR—short for polymerase chain reaction—to distinguish one pathogen from another by comparing unique segments of DNA, similar to tests used by law enforcement agencies. Telling the CVC pathogen apart from other strains of the bacterium has been one of the chief obstacles to rapid, accurate detection. Florida and other citrus-growing states are home to leafhoppers and other insects that could transmit CVC from tree to tree. But the pathogen also hides in dozens of woody plants and trees. The danger is that it could enter the U.S. undetected in plant species other than citrus. The citrus industry also needs a good diagnostic procedure to understand how CVC spreads and to develop effective control procedures. Two or three other PCR tests have been developed since the ARS test.

Fruit Laboratory, Beltsville, MD

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What if a crop plant could defend itself from an insect pest by damaging the pest's ability to make skin and grow? This defense is now being developed in molecular genetic and biochemical studies by ARS and cooperating scientists. They've genetically engineered tobacco plants to include an insect enzyme called chitinase, which breaks down chitin, a key component in insect "skin," and gut tissue. Chitin fibers play an important role when insects grow and shed their skin. In lab studies, the scientists found that the genetically engineered plants significantly suppressed the growth of feeding insect larvae. ARS and Kansas State University researchers are aiming their approach—based on chitinase from the tobacco hornworm, *Manduca sexta*—to provide a biopesticide alternative to traditional chemical pesticides such as methyl bromide. Currently, this chemical is sometimes used to protect raw and processed commodities. The ARS and KSU researchers hold a patent on the only known insect chitinase gene used in transgenic plants. While insect chitinase targets chitin, its presence in plants

is harmless to humans or animals. The researchers have been collaborating with several agricultural biotechnology companies to transform other plants including corn, rice, wheat and sorghum with the insect chitinase gene.

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Peanut crops could benefit from a new strategy that makes life miserable for noxious weeds. ARS and University of Georgia scientists devised the approach to help peanut farmers avoid the "herbicide treadmill." This term describes the costly practice of applying up to six different herbicides to keep pace with multiple weed species that compete with peanut crops—and each other—for space, sunlight and nutrients. In coastal plains states like Georgia, battling weeds with herbicides can cost peanut farmers roughly \$75 per acre. Texas panicum, yellow nutsedge and Florida beggarweed are among the peanut crop's most common and aggressive competitors. To even the odds, scientists combined cultural practices that help frustrate the weeds' germination and growth. One tactic employs the "stale seedbed" concept. This means preparing a seedbed of soil in an unplanted peanut field, then later plowing the top 3 inches to control weeds before they become established. A follow-up tactic, in late April to mid-May, calls for sowing peanut seed in narrow rows so the plants grow closer together. This fosters a quicker-developing leaf canopy than standard row patterns, and blocks late-season weeds from sunlight. The scientists' field studies indicate this approach could save peanut farmers an estimated \$12 per acre on herbicides. It could also prevent the need to increase peanut seeding rates. At up to \$100 per acre, peanut seed tops the farmer's list of production expenses.

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With a helping hand from science, smut could become the next weapon in the war on weeds. Smut—more specifically, loose kernel smut—is a natural fungus ARS scientists are experimenting with to kill Johnson grass, a noxious southern weed. The smut fungus, *Sphacelotheca holci*, causes a disease that turns the weed's seed structures into a black, crumbly mass. Scientists hope to encourage the microbe's mischief by formulating it into a mycoherbicide spray. They're conducting field tests to evaluate the spray's potential as a natural alternative to

conventional chemical herbicides. The chemicals help prevent Johnson grass from invading farm fields and outcompeting crop plants for space, sunlight, nutrients and water. But using herbicides is costly and raises environmental concerns. The fungus is an appealing alternative: It poses no danger of groundwater contamination, is naturally occurring and is very host specific. So, it poses little or no serious danger to grass crops like sugarcane, wheat and most sorghum varieties that succumb to other species of smut. In field trials, scientists observed plant infection rates of 50 to 80 percent after spraying the fungus onto Johnson grass seedlings—good, but not enough to prevent a noticeable drop in cane yield. Scientists now are contemplating ways to boost the fungus' virulence, or ability to cause disease in the weed.

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A hedge against sedge? That's what farmers could call a new chart that identifies 27 sedge species that are weeds of U.S. crops. Sedges are grasslike plants in the genus *Cyperus*. Some *Cyperus* sedges are useful, the most famous being *C. papyrus*, from which ancient Egyptians made paper. Generally, however, sedges cause problems on farms, in forests and in urban and other rural areas. Worldwide, they cost billions of dollars a year in crop competition and control measures. Botanically, where there's sedge, there's often confusion. To help U.S. farmers accurately identify these weeds, ARS researchers developed a reader-friendly table in cooperation with scientists in Arkansas and Florida. The genus *Cyperus* contains about 600 sedge species. Many are often misidentified as other weeds in the Cyperaceae family. This family includes sedges and much more: over 4,000 species in 90 to 115 genera. Currently, no single publication in the United States addresses these 27 *Cyperus* sedge weed species, including 14 native species and 13 exotic ones. One species, purple nutsedge, is considered by some to be the world's worst weed. The chart also contains information on yellow nutsedge, rice flatsedge and small flower umbrella sedge, all among the world's 34 worst weeds. Nomenclature, common names, distribution, ecology, biology and habitat data are presented for each species. Reprints includ-

ing the genera key and tables on native and nonnative *Cyperus* are available from the researcher.
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Plant Genetic Resources

A new potato that's highly resistant to late blight—the world's worst potato disease—is now available from ARS for plant breeders. Scientists hope the new spud, called Awn86514-2, can be bred with top-rated experimental potatoes or commercially successful varieties to boost their resistance to late blight. This fungal disease caused the Irish potato famine in the 1800s. New, more aggressive, fungicide-resistant strains of the disease-causing fungus have appeared in recent years. Breeding and testing to incorporate the new potato's resistance in new commercial varieties for farmers may take 6 to 10 years or more. In experiments by ARS scientists and colleagues in eight states and Mexico, Awn86514-2 held up well when attacked by new strains of the disease fungus, *Phytophthora infestans*. The new tuber also resisted attack by viruses that cause two other potato diseases, potato virus Y and potato leafroll virus. The potato's parents are an ARS-developed french fry variety called Ranger Russet and a spud selected from a collection sent to ARS by Poland's potato breeding institute. The average American eats about 143 pounds of potatoes a year, making spuds America's favorite vegetable.

Small Grains and Potato Research Unit, Aberdeen, ID
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A new mildew-resistant wheat breeding stock from ARS and cooperating scientists has surprised plant pathologists by warding off every strain of powdery mildew in their laboratory gauntlet. Previously, eight strains out of ten was the best any wheat could do. Commercial seed companies can use the breeding line, called NC97BG TAB-10, as a hybrid-parent to build mildew resistance into profitable, new soft red wheat varieties for farmers. Bakery cookies and cakes get their delicate texture from flour made with soft red winter wheat, which grows east of the Mississippi River. Powdery mildew hits the East's soft wheat types the hardest, costing growers between \$2 million and \$3 million annually. Scientists developed the new line from

wheat's hardy wild ancestors from the Middle East. The work was a collaborative effort with North Carolina State University.

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Home gardeners in the southeastern U.S. can soon grow a new southern pea that is ideal for producing fresh peas suitable for freezing. The new pea, "Petite-N-Green," can also be harvested when fully dry and stored as an attractive pack of dry peas. Developed by ARS scientists under a Cooperative Research and Development Agreement with Western Seed Multiplication, Inc., Oglethorpe, GA, the pea is the product of 8 years of intensive breeding. The plant grows low and bushy, producing pods in 70 to 76 days. Each pod is slightly curved, about 5 inches long with 14 peas. The dry peas are small—100 peas weigh about 1/3 ounce—and have a smooth seed coat. They can be restored to their near-fresh green color by blanching in boiling water for 3 minutes. Western Seed has the right of first refusal to an exclusive license to market the new cultivar. Breeders' seed will be maintained by the U.S. Vegetable Laboratory, Charleston, SC. Genetic material will be stored in the National Plant Germplasm System and will be available for future breeding efforts. Petite-N-Green seeds should be available to home gardeners by spring of the year 2000.

U.S. Vegetable Laboratory, Charleston, SC
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New peanut cultivars that withstand the root-knot nematode could come from a collection of resistant germplasm identified by ARS scientists. If breeding is successful, new cultivars would be commercially available within 5 years. For farmers, this won't be a moment too soon. Varieties they grow today generally can't survive severe nematode attack without chemical nematicide. Such attacks cost U.S. farmers up to \$30 million annually in losses and chemical controls. The nematode, a microscopic roundworm, inflicts its costly mischief by forming galls or knots on the peanut plant's roots, blocking nutrients and sapping vital energy. Female nematodes lay thousands of eggs on the roots, setting up farmers for a fresh round of losses next season. Researchers hope to break this cycle by crossing high-yielding cultivars with resistant plants from a collection of 36 strains that deprive the pests of a chance to feed and lay eggs. In greenhouse trials, scientists observed a 70 percent

reduction in the number of root galls and egg clusters on resistant plants compared with Florunner, a susceptible variety. The two most resistant plants, from Asia, showed a 90 percent reduction.

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Peanut breeders have a rich new source of genes to improve commercial peanut varieties, thanks to ARS-supported plant explorations. In 1995 and 1996, an ARS plant explorer and colleagues from Texas, Colombia and Ecuador traveled throughout Ecuador collecting more than 200 samples of native peanut varieties, commonly known as landraces. For centuries, indigenous farmers in Ecuador have selected peanuts that grow best under local conditions and have the characteristics they prize. Ecuadorian cultures have various uses for peanuts and select seed for specific traits, such as white peanuts for use in candy. The landraces collected include all six botanical varieties of peanut (*Arachis hypogaea*): *hirsuta*, *hypogaea*, *fastigiata*, *peruviana*, *aequatoriana* and *vulgaris*. Several of the landraces collected were previously unknown to science. Resistance to pests, diseases and environmental stresses are a few of the useful traits that may be found in the Ecuadorian landraces. The mission filled gaps in the U.S. peanut collection and reestablished a national peanut germplasm collection in Ecuador. In follow-up activities, the U.S. and Ecuador worked together to multiply and characterize the collected germplasm so that it can be used by peanut breeders around the world.

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Native wild onion plants may be easier to propagate from seed collected in the wild than from seed produced in a greenhouse or conventional field. To stock seed banks of these and other plants, ARS scientists are increasing their use of the approach known as *in situ* or on-site preservation. The agency maintains a network of repositories, known as the National Plant Germplasm System, to store seeds and other reproductive tissues of crop plants and their wild relatives. For researchers, this network is an invaluable tool for finding new genetic sources of disease resistance and other beneficial characteristics to breed into commercial crops. U.S. cultivated onion and garlic crops are worth more than \$900 million annually. But more than 60 American species in the onion family grow

in wild rocky places. Many species have not been incorporated into the repository system because they are difficult to propagate in traditional crop settings. So, scientists are trying to propagate them *in situ* by identifying areas where they grow naturally and collecting seeds from wild plants for storage. As a pilot test, they're looking at three species of wild onion in Washington: Douglas' onion (*Allium columbianum*) and Geyer's onion (*A. geyeri*) at the Turnbull National Wildlife Refuge west of Spokane and fringed onion (*A. fibrillum*) in the Umatilla National Forest outside Dayton.

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Finding and preserving a native wild grape called *Vitis rupestris* Scheele was the mission of an ARS scientist who drove and hiked more than 12,000 miles in the United States last summer. Rock grape is a prized rootstock because of its excellent resistance to diseases and insects and its ability to adapt to harsh environmental conditions such as drought. Finding wild rock grape plants undisturbed in their native habitat is a vital first step toward preserving the species' genetic potential for developing new grape varieties. Rock grape typically grows along rivers and creeks, on gravel bars and in areas with large boulders. Flooding may uproot and redeposit the plants or transport the fruits downstream, where seeds germinate. The ARS scientist looked for the plants in 60 waterways in 10 states—from Pennsylvania to Texas—where the plants had previously been collected. Because of stream channeling or other changes that eliminated the plant's habitat, she found it on only two dozen of the 60 waterways. At each site, she measured the plants, recorded physical data on 238 of the plants and took leaf samples for genetic screening. Her analyses identified populations that differed in specific favorable traits. Another ARS scientist at Geneva, NY, collaborated on screening the plants and evaluating plant populations for their genetic diversity using DNA markers. From these analyses, the scientists have proposed seven populations as *in situ* conservation sites.

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The nutritional quality of sorghum, the world's fifth leading cereal grain, could get a boost from 30 new breeding lines. ARS collaborated with Texas A&M University on developing and releasing the new lines as part of an ongoing program to improve sorghum. Some of the lines have higher levels of carotene, a nutrient the body converts to vitamin A. The new lines are tropical sorghums genetically converted to grow in temperate areas. As a result, they can produce an early grain crop in temperate areas, where long summer days mean more sunlight than along the Equator. The researchers developed the lines by crossing late-maturing sorghums from India, Ethiopia and Nigeria with early-maturing varieties. The scientists also released 30 partially converted lines that may be useful to researchers and breeders. ARS is exploring new biotechnology procedures to speed up sorghum breeding. By conventional methods, converting tropical sorghum germplasm into plants that will grow in temperate regions takes 5 to 10 years. *Tropical Agriculture Research Station, Mayagüez, PR*
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DNA markers on the new soybean genome maps allow rapid identification of plants carrying the two major genes that give resistance to the soybean cyst nematode. This pest robs U.S. farmers of an average of 220 million bushels of soybeans a year. The genome maps are proving useful in the ongoing hunt for two or three additional minor resistance genes. ARS scientists at Beltsville, MD, found and mapped almost 700 genetic markers that serve as road signs to genes on the soybean genome highway. Collaborators in the mapping research include researchers with the University of Nebraska at Lincoln, the University of Utah at Salt Lake City, ARS at Ames, IA, and a private company, BioGenetic Services, Inc. of Brookings, SD. ARS and Nebraska scientists are using the soybean maps for another first: identifying rare desirable genes in crosses between wild and commercial soybean lines. The genome maps enable them to pinpoint genetic material, including possible yield enhancing genes. Without such information, the chances of improving yield by crossing wild soybean (a vine-like weed) and commercial soybean would be unlikely. The mapping research was funded in part by the United Soybean Board.

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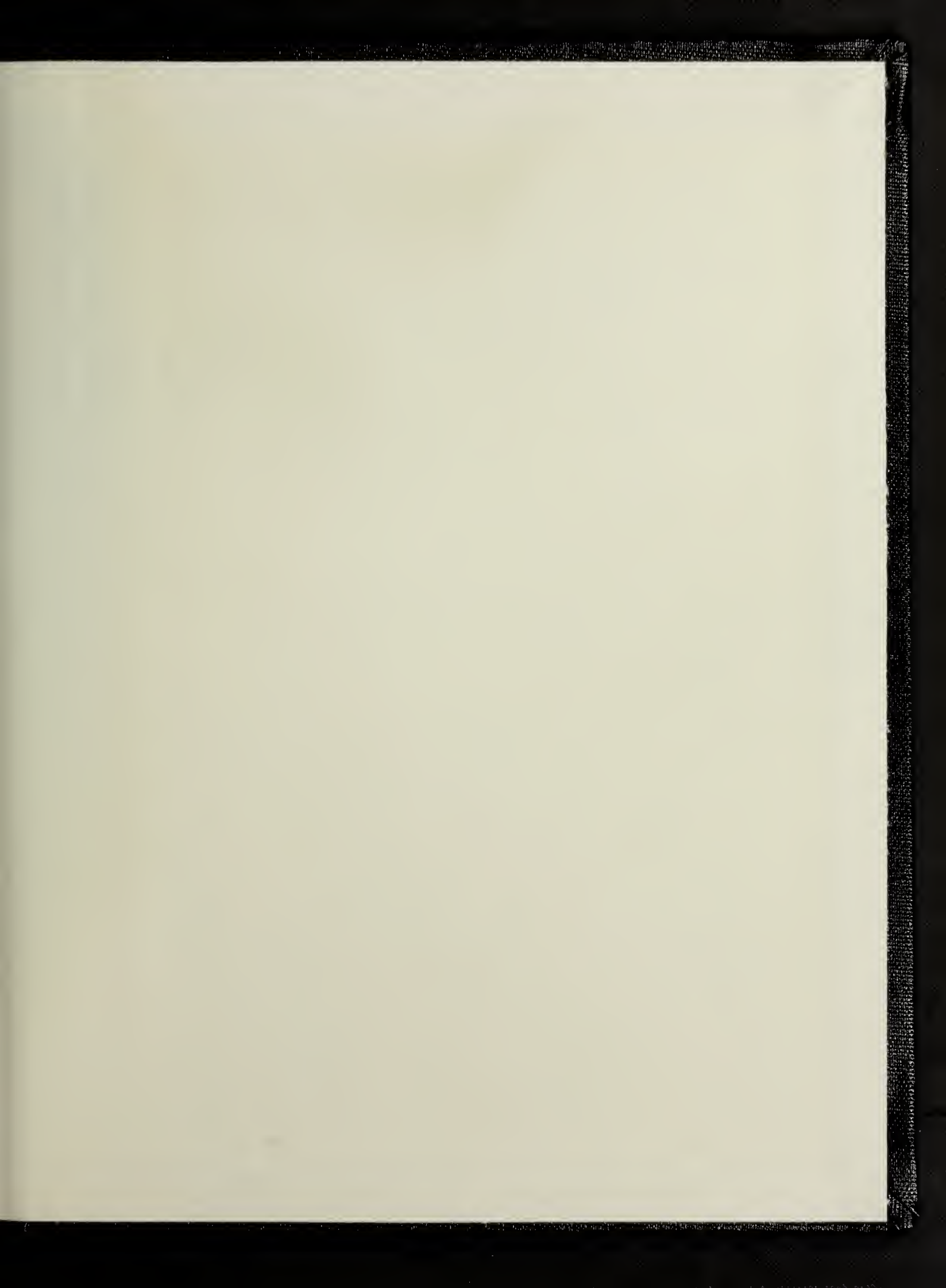
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